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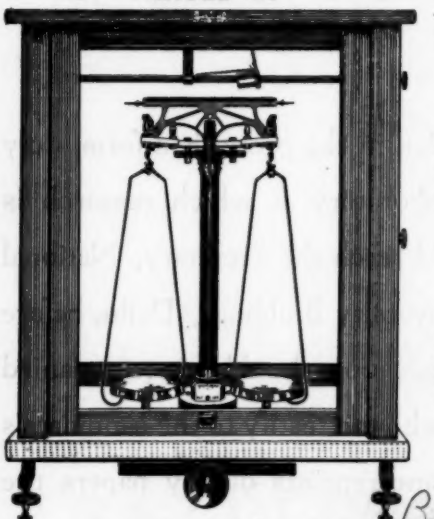

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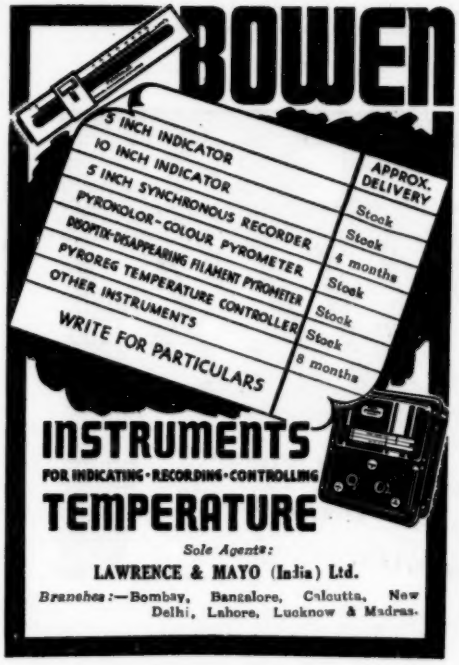

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Current Science

Vol. XVII] JANUARY 1948 [No. 1

	Page
The Eigenvibrations of Crystal Structures. Sir C. V. Raman	1
The Indian Society of Agricultural Statistics. P. V. Sukhatme	11
Rationalisation of Medicine in India	12
Technology of Rice	13
Physics of the Bottom Layers of the Atmosphere	16
The Place of Biochemistry in India	17
Letters to the Editor	19
New Theory of Smell	28
Reviews	29
Science Notes and News	31

THE EIGENVIBRATIONS OF CRYSTAL STRUCTURES*

1. Introduction

As is well known, the atomic architecture of a crystal may be described as a three-dimensionally periodic distribution of matter in space on a very fine scale. The regularity of such arrangement is, however, liable to be disturbed in various ways and especially by the thermal agitation in the crystal or by the incidence of radiations on it, and the atoms then vibrate about their respective positions of equilibrium. A knowledge of the modes and frequencies of the vibrations thus arising is of the greatest possible importance for the theory of the solid state. For, it enables us to evaluate the strength of the interatomic forces and thus to obtain a quantitative physical picture of the structure of the crystal, supplementing the geometric description furnished by X-ray analysis. Further, such knowledge is the basis for a development of the theory of the physical properties of crystals, including especially all those which depend on or are influenced by the temperature of observation.

The volume of papers under review is intended to furnish a definitive answer to the problem of ascertaining the modes and frequencies of vibration of the atoms in a crystal in relation to their geometric distribution in space and the forces holding them together as a rigid structure. Of the 19 papers forming the symposium, 9 describe new experimental results obtained from investigations specially designed to throw light on this fundamental problem. These experimental papers are richly illustrated, no fewer than 65 separate spectrograms

* *Symposium of Papers on the Vibration Spectra of Crystals*, December 1947, 190 pp. with 18 plates. Published by the Indian Academy of Sciences, Bangalore.

and 35 microphotometer records besides numerous diagrams being reproduced to aid the reader's understanding and appreciation of the results of the researches. The introductory paper of the symposium furnishes the necessary theoretical background, while the remaining nine papers are devoted to the consideration of the consequences of the theory in particular cases and their comparison with the facts of experiment. Before entering into a discussion of the theoretical aspects of the subject, it appears desirable to present the reader with a review of the experimental situation as it emerges from the symposium.

2. The Scattering of Light in Crystals

Many investigations on the vibration spectra of crystals have been made during the past twenty years by the method first employed in 1928 by the present writer, *viz.*, illuminating the crystal by monochromatic light and recording the spectrum of the scattered radiations emerging from it. While much empirical knowledge of value has accumulated as the result of such studies, they left untouched the fundamental problem of ascertaining what the *complete* vibration spectrum of any crystal is and of how it is related to the structure of the crystal. Investigations designed to resolve this problem were undertaken at Bangalore a few years ago by Dr. R. S. Krishnan. Numerous crystals have been studied with the utmost possible thoroughness and a rich harvest of results obtained in every one of the cases investigated, *viz.*, calcite, quartz, barytes, gypsum, fluorspar, corundum, topaz, diamond, rock-salt, sylvine, ammonium chloride, ammonium bromide. We shall presently proceed to take note of such of these studies as are now reported on. As an example of the results which previously found publication, we may mention the case of calcite, with which no fewer than 16 frequency shifts were recorded by R. S. Krishnan as against a maximum of 7 by earlier workers. The following facts observed with this crystal may be regarded as typical of those noticed with inorganic crystals generally. (*a*) The frequency shifts recorded with small or moderate exposures represent the *first-order* spectrum, namely, the fundamental eigenfrequencies of atomic vibration in the crystal which are active in light scattering. (*b*) In strongly exposed spectograms, frequency shifts are recorded with appreciable intensity which represent the vibration-spectra of higher orders, *viz.*, the overtones and summationals of the eigenfrequencies, including those not recorded as fundamentals. (*c*) The frequency shifts of all orders are recorded as sharply defined lines on a clear field, the apparent spectral width of such lines in many cases being no greater than that of the mercury arc lines registered on the plates with comparable intensities. (*d*) When the crystal is heated, the spectral lines broaden and shift towards the position of the exciting radiation and their peak intensities diminish notably. (*e*) *Vice-versa*, if the crystal is cooled to liquid-air temperature, the spectral lines sharpen and shift away from the exciting radiations while their peak intensities increase. But these effects are by no means so conspicuous as those of the opposite kind noticed on heating (see Figs. 1, 2 and 3).

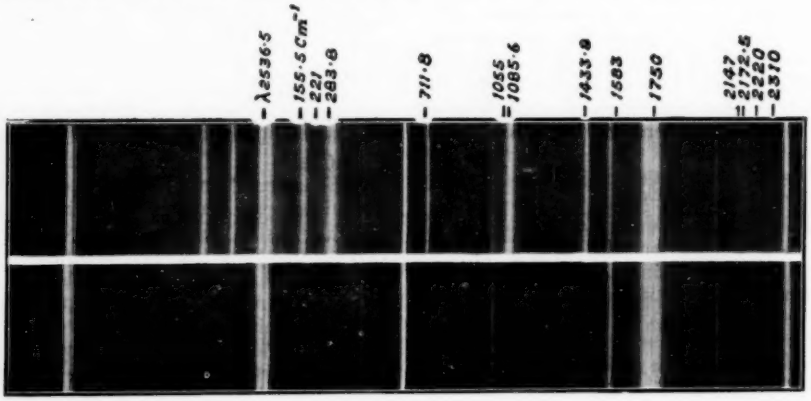

FIG. 1 *(a)* Raman spectrum of calcite. *(b)* Mercury spectrum (After Dr. R. S. Krishnan)

FIG. 2. Variation with temperature of the Raman spectrum of calcite (After P. K. Narayanaswamy)

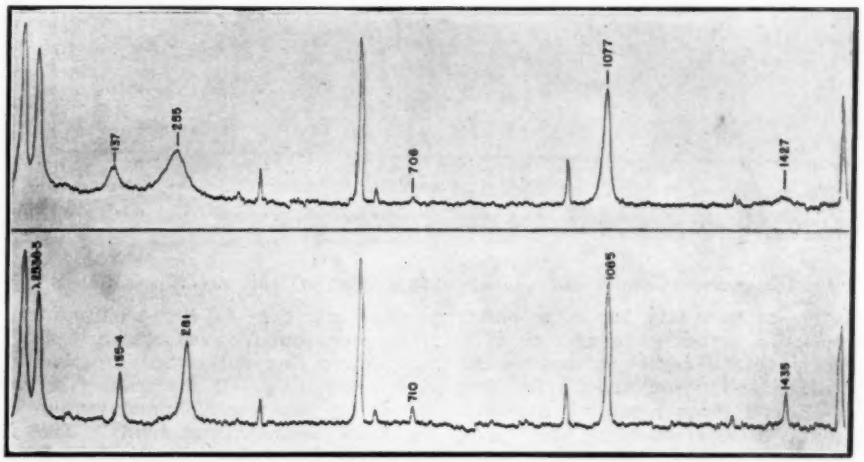

FIG. 3. Microphotometer records of the Raman spectrum of calcite at two different temperatures (After P. K. Narayanaswamy)

3. THE CASES OF CORUNDUM AND TOPAZ

These are two well-known crystals found in nature, while the former can also be prepared synthetically. Corundum is of much simpler composition and structure than topaz, and is a crystal of the trigonal class, while topaz is orthorhombic. These differences are reflected in the degree of complexity of their vibration spectra, 7 frequency shifts being recorded by Dr. R. S. Krishnan with corundum and 32 with topaz, as compared with a maximum of 2 and 11 frequency shifts respectively reported by earlier authors. The lower crystal symmetry of topaz evidently results in a much larger proportion of the possible modes of vibration being active in light-scattering than in the case of corundum. Fig. 4 reproduces, in part, the spectrogram of pure topaz obtained in light-scattering, while Fig. 5 is the *luminescence* spectrum of topaz containing a trace of chromic oxide as impurity recorded with the crystal held at liquid-air temperature. A comparison of the frequency shifts from λ 2536·5 as observed in light-scattering and from λ 6824·9 (the principal chromium line) as observed in luminescence shows a most remarkable concordance. The bands observed in the luminescence spectrum of ruby and also those observed in its absorption spectrum are successfully explained on similar lines in terms of the vibration frequencies of the corundum crystal observed in light-scattering and in infra-red absorption.

It is obvious that the mechanism of the diffusion of light by a crystal and the mechanism of its impurity-activated luminescence are very far from being identical. That nevertheless there is a concordance between the vibration-spectra as observed by the two methods is theoretically significant. It indicates that the vibration spectrum of a crystal as observed in light-scattering is not fundamentally different in its general character from the *complete* vibration-spectrum. In other words, the latter is essentially a *line-spectrum* exhibiting a discrete set of frequencies. This conclusion is reinforced by a vast array of other

evidence furnished by critical studies of the spectroscopic behaviour of numerous crystals by diverse methods reported in the literature during the last twenty years. It will not, however, be necessary for us to enter into a description or discussion of such evidence, since the facts regarding magnesium oxide discussed in *Current Science* for December 1947, and those regarding diamond and the alkali halides which we shall presently consider completely clinch the issue.

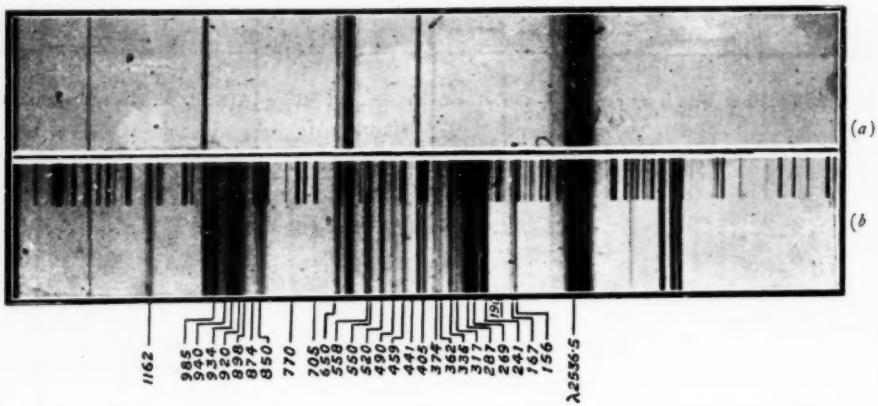

FIG. 4. *(a)* Mercury spectrum. *(b)* Raman spectrum of topaz (in part) (After Dr. R. S. Krishnan)

short exposures, while the second-order spectrum requires much heavier exposures. Under the high resolution provided by the Hilger E_1 quartz spectrograph, the Brillouin components due to the longitudinal and transverse sound-waves which reflect the light waves are successfully resolved from each other (Fig. 7), the transverse sound-waves for some unexplained reason giving the more intense components. The sound velocities of both kinds determined from the

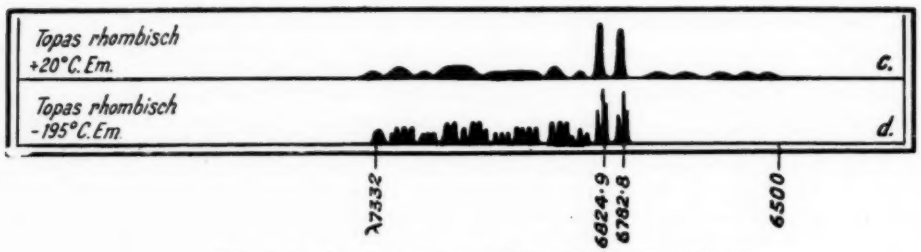

FIG. 5. Luminescence spectrum of topaz (After Deutschbein)

4. The Case of Diamond

Five of the papers in the symposium deal exclusively with the spectroscopic behaviour of diamond, and we may here briefly summarise their contents. Dr. R. S. Krishnan reports, in continuation of his earlier studies, a thorough investigation on the scattering of light in diamond, examined spectroscopically. The frequency shifts observed are of three kinds as indicated against them in Fig. 6; the Brillouin shifts in the vicinity of the exciting radiation λ 2536·5 are less intense than the first-order frequency shift of 1332 cm.$^{-1}$, but both are recorded with frequency shifts are found to vary with the direction of their travel [*vide* Figs. 7 (*a*), (*b*) and (*c*)] is to be expected theoretically. Their numerical values for the different directions agree fairly well with those determined by Bhagavantam and Bhimasenachar by the ultrasonic method. The same high-resolution spectrograph also suffices to resolve the spectrum recorded in the region of frequency shifts between 2665·4 cm.$^{-1}$ and 2015 cm.$^{-1}$ into discrete lines. The shift 2665·4 cm.$^{-1}$ which stands out very clearly in the spectrum as a distinct line is clearly the octave of 1332 cm.$^{-1}$

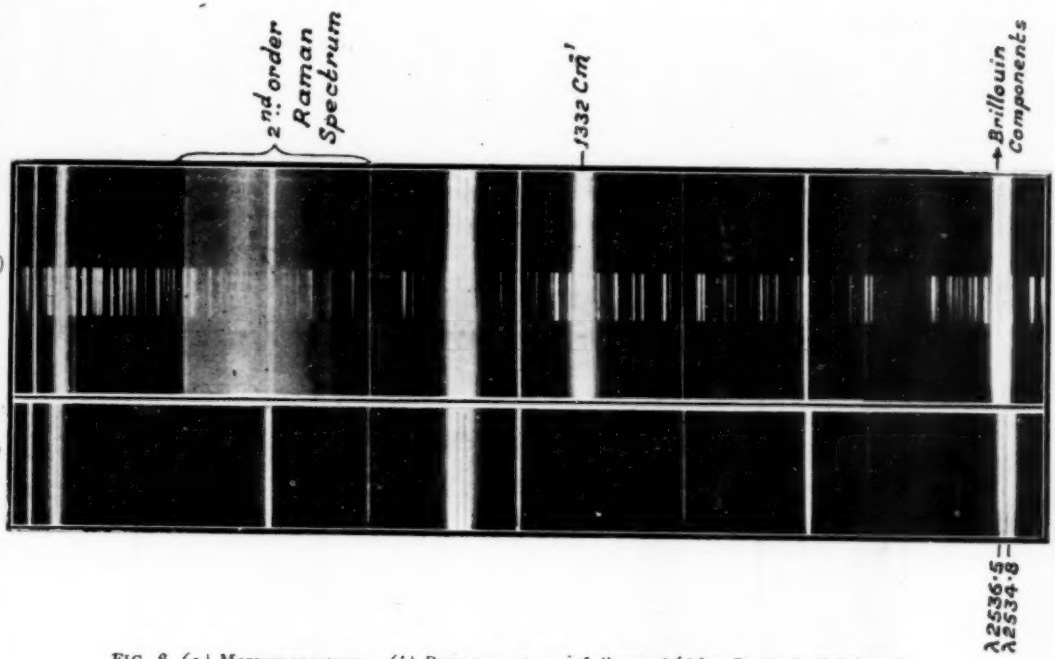

FIG. 6. *(a)* Mercury spectrum. *(b)* Raman spectrum of diamond (After Dr. R. S. Krishnan)

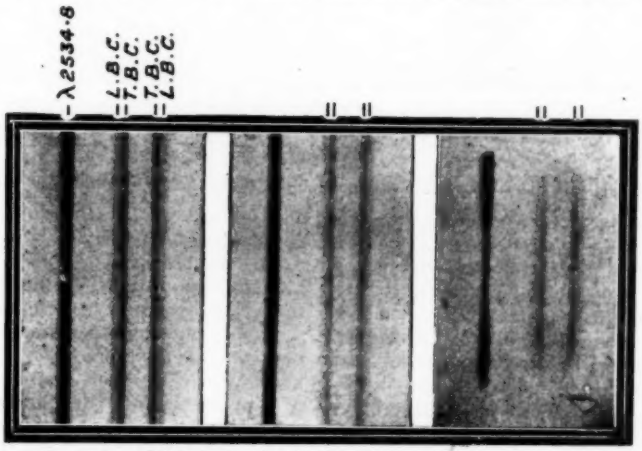

FIG. 7. Scattering of light by longitudinal and transverse sound-waves in different directions in diamond. (After Dr. R. S. Krishnan)

It is much less intense than the close doublet 2460-2470 cm.$^{-1}$, adjacent to which there are also several other lines (see Fig. 8). The terminal line at 2015 cm.$^{-1}$ is so feeble that it is not seen in the reproduced spectra but is quite clearly shown by a microphotometer record. The apparently continuous background seen in the second-order spectrum appears under high resolution as an aggregate of closely spaced lines which is part of the *third-order spectrum* and which appears superposed on it.

The infra-red absorption by diamond in the frequency range between 900 cm.$^{-1}$ and 4000 cm.$^{-1}$ has been surveyed by K. G. Ramanathan and a set of ten curves showing

much significant detail obtained with different diamonds is reproduced with his paper. The plates employed were of not very different thicknesses, but they differed much in their physical properties such as ultraviolet transparency, luminescence, birefringence, and photoconductivity. The ten infrared absorption curves exhibit a practically

obtained by diverse methods of observation, *viz.*, first and second order scattering of light, infra-red absorption of the first and second orders—the former varying from diamond to diamond while the latter remains invariable—luminescence of various types, as also the related absorption. An intercomparison of the results obtained

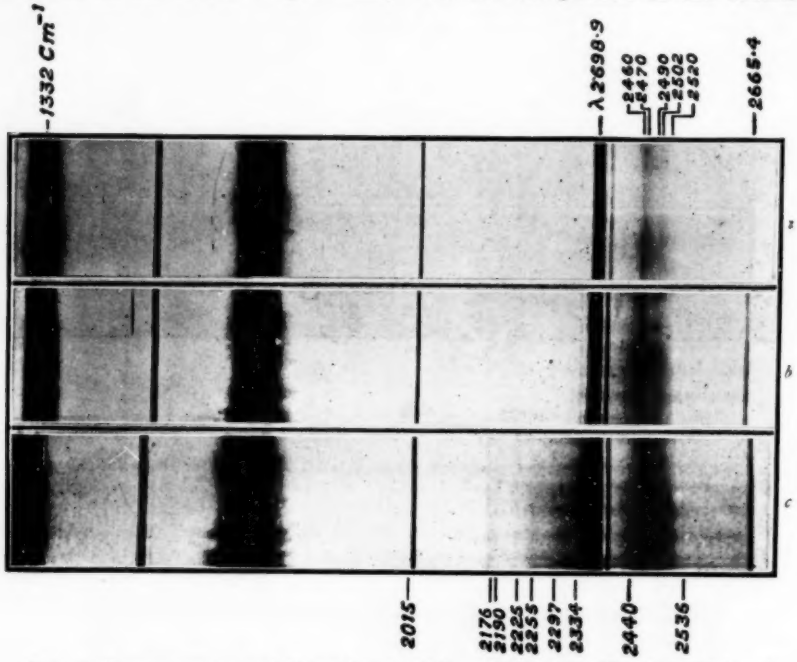

FIG. 8 Raman spectrum of diamond under high resolution (After Dr. R. S. Krishnan)

continuous sequence of variation, ranging from complete transparency in the region 900-1350 cm.$^{-1}$ to nearly complete opacity in the same region, and such variation also shows a complete correlation with the variations of the other properties referred to. With another paper by the same author, the emission and absorption spectra of blue-luminescent diamonds and their microphotometer records are reproduced. The discrete character of the blue-luminescence spectrum is evident from the reproductions (see Fig. 9), and the measured frequency differences from the principal emission line at λ 4152 indicate very clearly that we are concerned here with the characteristic vibration frequencies of the diamond structure.

Thus, in the case of diamond, we have a wealth of experimental material regarding the nature of the vibration spectrum

by different methods taking into account the different circumstances of observation, shows a remarkable concordance, which is exhibited diagrammatically in Fig. 10. The observations themselves clearly indicate that the diamond structure has a set of discrete modes and frequencies of vibration which are finite in number, these appearing in the first-order spectra as fundamentals and in the second-order spectra as their overtones and summationals. The fundamental frequencies deduced from the observations are in cm.$^{-1}$, 1332, 1250, 1232, 1149, 1088, 1006, 752 and 620, being just 8 in number. The dynamical theory set out in the introductory paper of the symposium leads to the result that the structure of diamond has nine characteristic modes of vibration of which the fifth and the sixth are indistinguishable, thus giving us only eight eigenfrequencies.

The identification of these with the eight experimentally observed frequencies therefore naturally suggests itself, but such identification evidently demands an independent proof before it can be accepted as convincing. The two other papers on the case of diamond appearing in the symposium, respectively by the present writer and by Mr. K. G. Ramanathan, furnish the required demonstration.

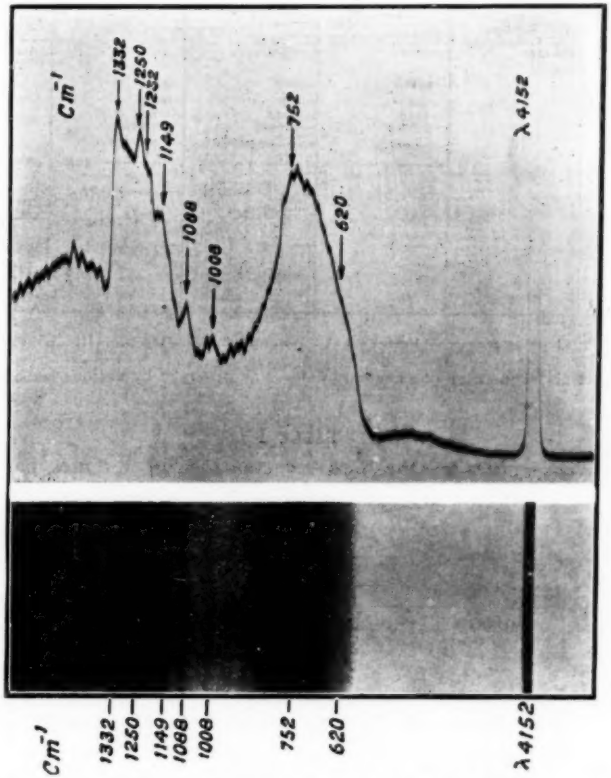

FIG. 9. Blue-luminescence spectrum of diamond and its microphotometer record (After K. G. Ramanathan)

The nine eigenvibrations of the diamond structure are readily described. Eight of them arise from the existence of three sets of alternative possibilities, namely, an oscillation of the cubic (octahedral) planes in a direction normal (tangential) to those planes, the nearest layers of carbon atoms being in the same (opposite) phase of motion. The ninth mode is a movement of the two sets of carbon atoms forming the structure against each other. Owing to the high symmetry of the structure, the number of independent force-constants required to evaluate the frequency of any one of these modes is very considerably reduced. Actually, three force-constants (P, Q, R) which express the interactions with the nearest four atoms are sufficient to give a fair approximation to the facts, while eight constants (P, Q, R, S, U, W, Σ, Ω) which take account of the 28 nearest atoms are all that are needed. The values of P, Q, R which fit the experimental data are found to be related to each other in a manner which one would expect from the known physico-chemical structure of diamond (*viz.*, $P > 4Q$ and $2Q > 2R > Q$). The values of the remaining five constants which express the interactions with distant atoms come out very small as is to be theoretically expected. Tables I and II, reproduced from the paper by K. G. Ramanathan, exhibit this situation very clearly.

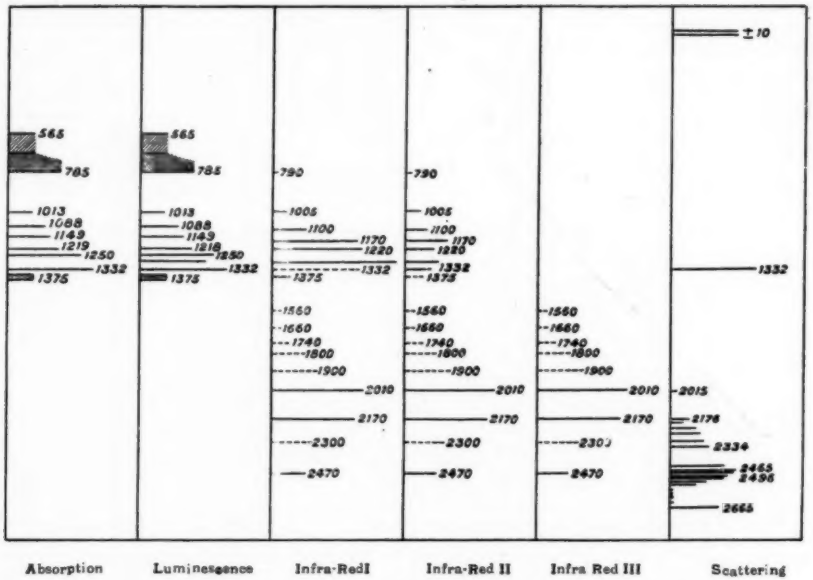

FIG. 10. Spectral frequencies of diamond in cm.$^{-1}$ as observed by various methods

TABLE I

Numerical values of the force-constants $\times 10^{-5}$ *dynes per cm.*

Atom 0	Atoms 1 to 4		Atoms 5 to 16			Atoms 17 to 28	
P	Q	R	S	U	W	Σ	Ω
7·35	−1·39	−0·858	−0·005	−0·131	−0·114	−0·06	+0·005

TABLE II

Calculated value of the frequencies of diamond

Sequence	Degeneracy	Operative Force-constant	Frequencies from abbreviated formulæ			Complete Formulæ
			P only	P, Q, R	P, Q, R S, U, W	
			cm.$^{-1}$	cm.$^{-1}$	cm.$^{-1}$	cm.$^{-1}$
I	3	$P-4Q+4S+8U-12\Sigma$	1020	1 51	1294	1332
II	8	$P-2Q-2R+4W+6\Sigma+6\Omega$	1020	1294	1269	1250
III	6	$P-4R-4S-12\Omega$	1020	1234	1236	1232
IV	4	$P+2Q-4R-8W-6\Sigma+12\Omega$	1020	1064	1123	1149
V & VI	3+3	$P+4S-8U$	1020	1020	1088	1088
VII	4	$P-2Q+4R-8W+6\Sigma-12\Omega$	1020	973	1038	1008
VIII	6	$P+4R-4S+12\Omega$	1020	744	746	752
IX	8	$P+2Q+2R+4W-6\Sigma-6\Omega$	1020	635	582	620

The agreement of the frequencies computed theoretically with those observed and the reasonable values of the force-constants which have to be assumed to fit the data are both impressive. But even a more striking confirmation of the correctness of the identifications comes to hand when we consider the *activity* of the various modes in light-scattering and infra-red absorption on the basis of the known structure of diamond and compare the same with the facts of observation. This is done at considerable length in the second paper of the symposium, and

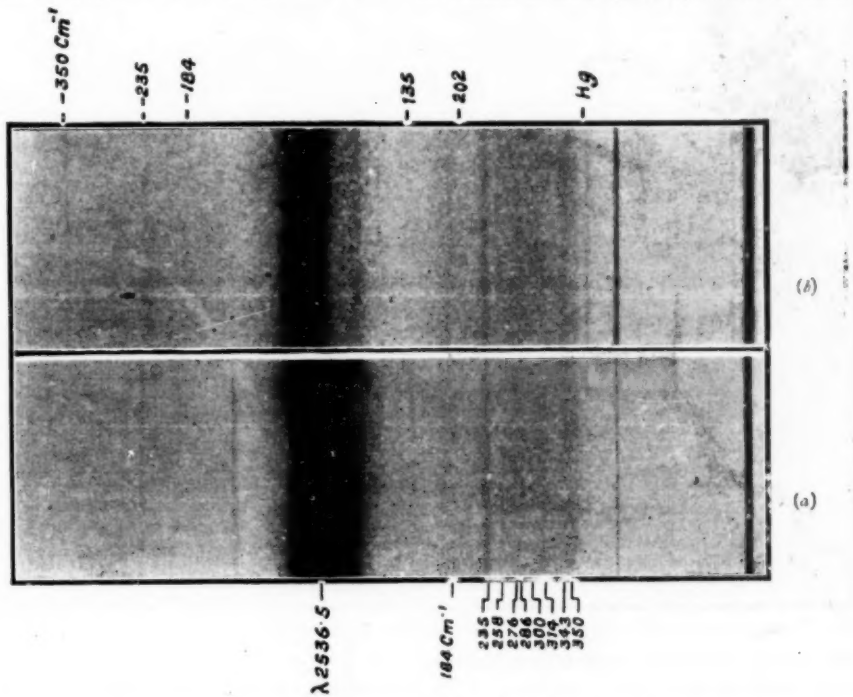

FIG. 11. *(a), (b)* Raman spectrum of rock-salt recorded under high and low resolving powers
(After Dr. R. S. Krishnan)

the concordance which emerges is so satisfying as to leave no doubt whatsoever of the correctness of the theoretical approach made to the problem.

5. The Alkali Halides

The symposium under review includes papers by Dr. R. S. Krishnan describing and discussing the results of his investigations on the scattering of light in two of the alkali halides, namely, rock-salt and ammonium chloride, which are both cubic crystals. Fig. 11 (*a*) and (*b*) reproduce the spectrum of rock-salt as recorded by him respectively with the larger and small Hilger quartz spectrographs, but enlarged in both cases to the same size. It will be noticed that the frequency shift of 235 cm.$^{-1}$ appears distinctly sharper and that the other details are also seen more clearly in the spectrum recorded with the larger instrument. This is also evident from the microphotometer records reproduced with the paper which show significant differences in the distribution of intensity as recorded with the two instruments. In particular, the frequency shift 235 cm.$^{-1}$ shows a large gain in intensity relatively to the other features and indeed overtops all of them in the microphotometer record of the spectrum (see Fig. 12) which is not the case when the smaller instrument is used. This is precisely what we should expect to find when a higher resolving power is brought to bear upon a closely spaced aggregate of spectral lines of differing intensities. In other words, the comparative microphotometric study reveals that the

rock-salt spectrum is an aggregate of discrete lines and that the frequency shift of 235 cm.$^{-1}$ shows up a distinct line even under a low resolution just because its intrinsic intensity is much greater than that of the other lines crowded together in the spectrum.

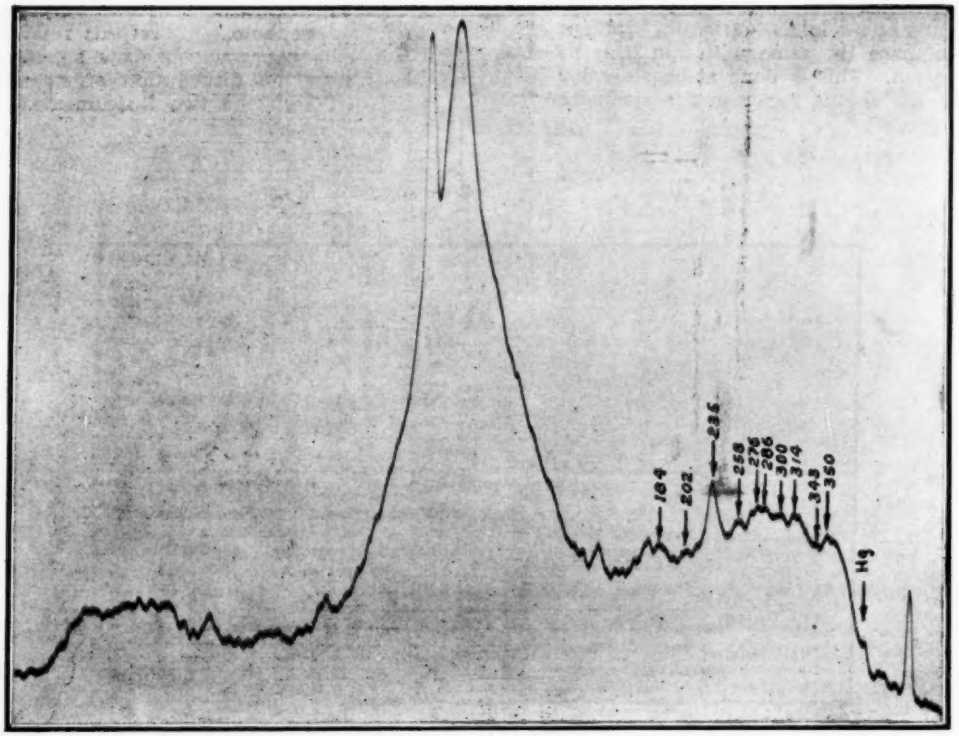

FIG. 12. Microphotometer record of the rock-salt spectrum under high resolution (after Dr. R. S. Krishnan)

The large intensity with which the frequency shift of 235 cm.$^{-1}$ appears finds a simple explanation in the theory of the vibrations of the rock-salt structure developed and discussed in the symposium. One of the nine possible eigenvibrations of the structure represents an oscillation of the chlorine ions contained in the octahedral planes of the crystal in a direction normal to these planes, the intervening layers of sodium ions remaining at rest. Owing to the large mass of the chlorine ions, this particular oscillation has a low frequency, being in fact the sixth among the modes in the descending sequence of frequency. The chlorine ions have, however, a large refractivity, indeed very much larger than that of the sodium ions, and hence the alternate approach and recession of the octahedral layers containing them results in much greater variations of optical polarisability than in the case of any other mode. These variations in the successive layers cancel each other's effects in the first approximation, but in the second approximation a residue is left over which results in a frequency shift of double the frequency appearing with quite notable intensity. It is evident from Fig. 12 that the spectrum also contains numerous other lines, most of which are barely resolved from each other. This is scarcely surprising when we recall that the second-order spectrum of rock-salt should exhibit 45 separate shifts, to say nothing of the third-order spectrum which is also in part superposed on it.

The results obtained with ammonium chloride are also of great interest in view of the remarkable changes which occur in the spectrum of this substance when the temperature is varied. We have not, how-

ever, space here to refer to them in detail, and the interested reader will no doubt, consult the original paper.

6. Some Concluding Remarks

The spectroscopic behaviour of diamond as observed in light-scattering which has been described and discussed above, and the behaviour of crystalline magnesium oxide as observed in infra-red absorption, described and discussed in *Current Science* for December 1947, clearly demonstrate that the complete vibration spectrum of a crystal in the higher ranges of frequency is a discrete *line-spectrum*. In view of the thoroughness with which these two cases have been investigated, and the simplicity of the structure and composition of both the crystals, the experimental facts which have been observed with them are acid tests for any theory which concerns itself with the atomic vibrations in crystals and claims to be able to explain the physical phenomena resulting from such vibrations; any theory which cannot account for the facts noticed with these two crystals or leads to results different from those observed must necessarily stand discredited. *Per contra*, a theoretical approach to the subject which leads to a simple and natural explanation of the facts observed with diamond and magnesium oxide must at least be on the right lines. This is the claim made on behalf of the theory of the eigenvibrations of crystal structures set out and discussed in the introductory paper of the symposium.

C. V. Raman.

THE INDIAN SOCIETY OF AGRICULTURAL STATISTICS

THE first Annual Meeting of the Society was held at New Delhi from the 11th to the 14th December 1947. The meeting opened on the 11th with the Presidential Address by the Hon'ble Dr. Rajendra Prasad, Minister for Food and Agriculture, and President of the Society. The President referred to the poor quality of the published agricultural statistics and stressed the urgent need of improving it both as regards completion and accuracy, as, without reliable statistics, no planning of any kind was possible. Although food was the greatest problem facing the country, no policy for food could be formulated for want of reliable data. Emphasising the need for building up of an adequate statistical organisation, he urged statisticians to develop scientific methods like those of random sampling and air photography for reducing the cost and time in collecting data.

On the 12th December, a symposium on 'Statistical Organisation for India with special reference to Agriculture' was held under the chairmanship of the Hon'ble Mr. R. K. Shanmukham Chetty, Minister for Finance. Opening the symposium, he said that the building up of a statistical organisation must really be given top priority, for, the Government cannot plan in a rational manner its food policy without reliable statistics. He said that the Government was just considering proposals for strengthening the central statistical organisation and was examining as to how far individual departments should be engaged in the collection of statistics and to what extent the central organisation should control the collection in individual departments and in what manner it should co-ordinate it, and added that the Society's guidance in these matters would be most valuable. The main speakers were Dr. V. G. Panse (Indore) and Mr. W. R. Natu (New Delhi). They emphasised the need for decentralisation not only in regard to the collection of statistics but also for the training of statistical personnel and research in statistical methods, as, in their view, a close contact with the field to which Statistics is applied is absolutely essential for the growth of efficient statistical service. Others participating in the symposium were Prof. K. B. Madhava, Mr. K. Kishen (Lucknow), Mr. R. S. Koshal and N. S. R. Sastry (Bombay) and Dr. P. V. Sukhatme (New Delhi).

On the 13th December, a second symposium on the contribution of 'Statistical Science to the Development of Indian Agriculture' was held under the chairmanship of Prof. J. N. Warner of the Allahabad Agricultural Institute. Dr. N. S. R. Sastry, opening the symposium, dwelt on the role of statistical science in agricultural economics. He was followed by Messrs, V. D. Thawani, M. A. R. Roy, Mr. V. R. Rao, Mr. S. S. Iyer, Mr. S. D. Bokil, Mr. K. Kishen, Mr. R. S. Koshal and Mr. M. V. N. Rao, who described the varied applications of statistics in different branches of agriculture including plant breeding, design of experiments, animal husbandry, fisheries, etc. One the 14th December, papers were read with Prof. K. B. Madhava in the chair.

It was announced at the meeting that arrangements for the publication of the Society's Journal were nearly ready. A special feature of the Journal would be a Hindi supplement giving summaries of the articles published.

P. V. Sukhatme.

539605

RATIONALISATION OF MEDICINE IN INDIA*

THE development of medical science in India is a fascinating study. In its long history it has suffered repeated impacts with foreign systems, the latest being the Western allopathic system.

At present, in this vast country, medical relief to the masses is carried out by two agencies—the Indigenous and Western.

Indigenous medicine is being practised by a vast number of practitioners. Unfortunately only a small portion of these have received proper systematic training. It is this class of untrained or improperly trained practitioners, which at the present time attends to the needs of the major portion of the rural population. There is evidence to prove that unauthorised practice is responsible for producing much misery and suffering. There are, however, some important considerations in favour of the indigenous medicine, if properly practised. The first is that the materia medica used is derived entirely from indigenous sources and, therefore, is inexpensive. The second is that these systems are ingrained among the people who have faith in the treatments prescribed and the drugs used. That there is much in the Indigenous Medicine, especially in its materia medica, is beyond doubt. But even with a background of its glorious past, Indigenous Medicine, it is believed, cannot play as effective a part, nor take its proper place in the present-day medical relief in this country. They will first have to put their house in order and become cognisant of the present-day environments and their requirements. The practitioners will have to be properly trained, and unauthorised practice will have to be rigidly eliminated. The true spirit of research and discovery will have to be inculcated and irrationalism excluded from diagnosis and treatment of diseases. The discoveries which have proved effective beyond doubt in the treatment of disease must be accepted and incorporated, and all inherent prejudices discarded to achieve the one sublime object of the alleviation of human suffering.

The second agency of medical relief is through the practitioners of Western medicine. Though it has a scientific basis and is, therefore, much more amenable to rational practice, it unfortunately does not reach much more than 20 per cent. of the population. The reason for this tardiness is not far to seek. The economic condition of masses of people is very low, and there are millions who cannot afford any kind of treatment.

Irrational Practice of Modern Medicine

Quite in contrast to the Indigenous Medicine, Western Medicine has made enormous strides, both in connection with the causation of disease and its treatment. But in spite of this there is a regrettable tendency on the part of the practitioners towards mere empiricism. Non-critical and irrational use of therapeutic agents is rather the rule than the exception. In fact if the state of medical practice in India is examined without prejudice, one is forced to the conclusion that with the exception perhaps of a small number of institutions and of a comparatively small number of practitioners, the practice of Western Medicine is not a shade better than that of Indigenous Medicine. One dare not estimate the harm that has been done through the indiscriminate use of powerful remedies which science has placed in the hands of practitioners. It is a sad commentary on things that though Western medical science has been well established in the whole country for at least half a century, if not more, it has not yet succeeded in making the average educated men more health conscious, to say nothing of the uneducated and ignorant masses. There has been little progress during the last forty years or so, in the rationalisation of the practice of Western Medicine generally in this country. The blame does not lie wholly at the door of the general practitioner.

Why Rational Medicine is not Practised

One of the chief reasons why rational medicine has not been practised is that those responsible for the government in this country in the past have neglected the growth of the nation-building health services. The *per capita* expenditure has in the past been absurdly low compared with what should have been spent. "India should have spent annually Rs. 3-3-0 per head of the population, if her expenditure on health services were to bear the same relation to the national income as the amount spent in Great Britain in 1934-35." But the combined expenditure on medical relief and public health activities in the provinces during 1944-45 ranged between 2·8 annas *per capita* in the C.P. to 10·9 annas in Bombay. It is, therefore, not surprising that medical education and medical research which form the foundation of rational medicine have suffered seriously. The teaching institutions are too few and many of those that exist are poorly equipped and inadequately staffed.

Medical education should be carried out on much broader and sounder lines than heretofore if the present low standard of medicine in India is to be raised. This can only be done by improving the educational institutions, both as regards their teaching staff and equipment. In Great Britain, the proposed National Health Service will bring into being the Health Centre, an institution which it is intended should provide the general practitioner with all modern methods of diagnosis and treatment. If the medical practice in this country is to be rationalised adequate provision will have to be made on similar lines.

Medical Research

There is no doubt that rational medicine cannot be practised unless there is extensive medical research. The annual grant for medical research by the Government of India, till recent years, was only a paltry sum, and even this was cut down through the recommendation of the Inchcape Commission. The research worker is poorly paid, and the best talent takes up practice because it is more remunerative. With

* Extracts from the General Presidential Address by Sir Ram Nath Chopra, to the Thirty-Fifth Session of the Indian Science Congress, Patna, 1948.

all these disabilities it is not surprising that the standard of medical practice is low, and scientific or rational medicine has not been practised.

The immediate implementation of a progressive plan like the one put forward by the Bhore Committee will enable us to draw abreast of recent knowledge and to introduce in our country up-to-date teaching and research, and what is best in the health administration of advanced countries.

Trained personnel is the most important single factor for provision of adequate medical relief on rational lines. We need at least ten times the number we have, and it will take 30 to 40 years to train this number. It is imperative, therefore, that we make the most of what we have. The present retiring age in services is 55 years, when most of the incumbents are yet fit to carry on efficiently for many more years. They should be made to work as long as possible and, if necessary, their sphere of work should be changed to suit their physical capacity. When we come to highly specialised workers, such as research workers, of whom we have a still less adequate number, it would be foolish to retire them, as is the usual practice, when they are most valuable for training and directing other workers and organising new institutions.

The Role of Indigenous Medicine

There are many people who consider that while a comprehensive and rational system of public health is being evolved, use should be made of Indigenous Medicine. Indigenous system—good, bad or indifferent—still caters for the needs of the major portion of the population particularly in rural areas. They, therefore, consider that it cannot be excluded altogether from the field, and urge that it be used to the best advantage while the process of evolution of a perfect system of rationalisation of medicine is being worked out. During this transition period, they also hope that Indigenous Medicine will overhaul itself and becomes an integral part of the permanent system evolved.

For the rationalisation of medical practice in India two important points suggest themselves. Firstly, the practice of medicine be so regulated by the exponents of modern and of the indigenous systems that the fullest possible use can be made of the facilities available for diagnosis, treatment and prevention of disease. The second point is that a synthesis of indigenous and modern systems of medicine be attempted so as to promote the utilisation of the knowledge from all available sources for the interpretation of health and disease. Both extension and acceleration are possible through a partial synthesis of the two systems in the elementary stage of our teaching. The present course of study in the indigenous medicine should be suitably curtailed on one side and enlarged on the other. The net effect of this suggestion will be twofold. It will shorten considerably the period of study, and thus will lead to the training of a much larger number of qualified practitioners. And secondly, while giving the students a sufficient background of scientific knowledge with regard to the diagnosis, treatment and prevention of disease, it will make them at the same time conscious of their own limitations and of the necessity to appeal to higher practice in difficult cases. There are about a hundred thousand practitioners of indigenous medicine in India, many of whom could be quickly fitted for this purpose after suitable training. The services of such practitioners will be of particular value in the rural areas, which are now almost beyond the reach of modern medicine. Rural medical relief will be considerably facilitated if some further steps are taken to standardise medical practice by prescribing uniform scales of drugs and medical appliances for institutions, their production in bulk and distribution under the auspices of the State. If all practitioners are properly registered, and practice by non-registered practitioners prohibited, a reasonable standard of competence could be secured.

N. N. De.

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TECHNOLOGY OF RICE*

THE number of named varieties of rice is said to exceed two thousand. Hundreds of varieties are cultivated. There exist between these varieties marked differences in quality as revealed by consumers' preferences. Attempts have been made to correlate quality in rice with certain chemical and physico-chemical properties of the cereal, but rarely with success. Extensive investigations were carried out at the Central College, Bangalore, to correlate varietal differences in physical properties with the quality of rice. A study of sorption and desorption of water by rice grains showed that, in general, superior varieties of rice lose water more readily during dehydration, and take up water at a faster rate during hydration, than varieties of poorer quality. This showed greater permeability of the grain to moisture in superior varieties. Other physical properties did not exhibit any useful correlation with quality.

The observation on sorption led to an extensive investigation of the swelling of rice grains when cooked. Correlation between absorption of water and cooking quality furnished a convenient method of expressing it in quantitative terms by "Swelling Numbers". This simple method of determining cooking quality has been in use at the Central College for over ten years and has been found to give highly reproducible results.

Important conclusions arrived at from these experiments were: (*a*) Rice from freshly harvested paddy (which is notorious for its poor cooking quality) gives a very low swelling number, (*b*) storage or proper heat treatment improves the cooking quality of freshly harvested paddy, (*c*) overcuring adversely affects

* Abstract of Presidential Address delivered by Dr. B Sanjiva Rao to the Chemistry Section of the Indian Science Congress, in January 1948, at Patna.

the quality and (*d*) parboiled rice swells less than raw rice when cooked under the same conditions.

It is obvious that any process that cuts short the curing process will be of economic importance.

The unsuitability of rice from fresh paddy as food seems to be due to at least two causes. One is its poor swelling quality when cooked. Cooked rice that has swollen presents a large internal surface at which the digestive enzymes can be adsorbed and can act efficiently. Another reason for the poor quality of rice from fresh paddy seems to be the poor permeability of the envelope surrounding the starch granules.

The swelling of starches has received considerable attention in recent years. It is generally recognised that the starch granules enlarge by tangential expansion and not by development of internal, radially directed pressure. Swelling is influenced by the following factors: (1) original size of granule; (2) relative percentages of amylose and amylopectin; (3) extent of crystallisation of starch and the nature of the crystallites in the granules; and (4) whether the structure of the granule has been previously influenced by chemical or physical treatment. Some of these factors are of particular importance with reference to processes for curing rice. Hydrogen bonding seems to play a part in the swelling of starch. Cations have been found to have a marked effect on the swelling.

It should be noted that all these investigations on the swelling of starch have been carried out with granules that have been detached from their natural setting in the raw material. We are concerned, however, with the overall swelling of the rice grain in its cooked state as served at the table.

The principal material that binds the starch granules into a rigid structure seems to be the protein in rice. It is well known that proteins form complexes with carbohydrates. The latter also form complexes with fats, phosphoric acid and silicic acid. Sjostrom pictures the granules in the rice grain enclosed in honeycomb-like structures of gluten, and states that in the aggregates the granules are held together by the gluten particles. Protein (about 1 per cent. of the grain) seems to be the binding material in the production of a coherent structure from small glycogen units. The framework of the rice grain is, under certain circumstances, rather a delicate structure. In processes for the curing of rice, this has to be constantly borne in mind.

It has already been pointed out that one of the facors affecting the swelling of starch granules is the relative proportion of amylose and amylopectin, which constitute two distinct fractions of starch. Investigations were carried out at Central College to find out how far varietal differences in amylose-amylopectin ratios would affect the swelling numbers of the different varieties of rice. It was found that there was a close correlation between the amylose content of a rice and its swelling number. The question arises if the amylose-amylopectin ratio of a rice can be altered by appropriate treatment and the cooking quality of the rice thus improved. It was, however, found that heat treatment of paddy by methods like parboiling did not affect the amylose-amylopectin ratio. Haworth has suggested a scheme for the synthesis and breakdown of amylopectin and amylose by the P. and Q. enzymes of potato. P. enzyme under appropriate conditions acts on amylopectin to yield amylose. Much more knowledge of the action of the enzyme, however, will have to be obtained before we can hope to alter the quality of a rice by enzymatic action.

In starch there is a strong tendency for the formation of "Interlocked macromolecules". The formation of cross-linkages in the macromolecules reduces swelling capacity. We may look upon rice as a colloidal system which has limited swelling capacity owing to the presence of cross-linkages.

Rice in fresh paddy is in a large measure in the hydrogel condition. As the rice ages, there is elimination of water due to syneresis. As syneresis proceeds, cross-linkages are formed, and there is greater rigidity in structure until, ultimately, on adequate storage, we are able to husk the rice without undue damage. It may be noted that in the rice grain there are capillary spaces, as in silica gel. Employing a special technique, M. R. A. Rao actually measured the volume of air entrapped in rice capillaries. The work of Subba Rao showed that some of the cavities in rice were of molecular dimensions. The hysteresis loops in rice disappeared on successive sorption and desorption of water vapour, but not of carbon tetrachloride vapour, by the rice. When rice grains undergo a series of sorptions and desorptions, there is considerable gain in the elasticity of the walls leading to the final disappearance of the hysteresis loop.

Parboiled Rice

The fact that rigidity in structure in the rice grain can be attained by the application of wet heat and the consequent development of cross-linkages, is of great practical importance and is the basis of several methods of curing rice. One of the oldest of such methods, practised in India, is the parboiling of paddy. The out-turn of parboiled rice is usually 6 to 10 per cent. more than that of ordinary milled rice and the process conserves the water-soluble vitamins of the B group, the proteins and the mineral matter in rice. When rice has been properly parboiled, the keeping quality of the rice also improves, partly because the vitamins in the cured rice are not readily available to the weevils. Another important advantage of parboiling is that when parboiled rice is washed, prior to its cooking (and rice invariably is washed before it is cooked), the loss of thiamin is about 8 per cent. only, while raw milled rice loses 60 per cent.

It must be mentioned, however, that the process as practised by the trade in India is far from perfect and is in great need of standardisation and quality control. The need for reform in parboiling has also been emphasised by the Rice Study Group of the FAO.

The chief defects of improperly parboiled rice seem to be: (1) objectionable odour, (2) uninviting taste, and (3) toughness of the cooked grain. The first two undesirable features can be eliminated to a large extent, by reducing the period of soaking of paddy and by employing hot water for soaking. This aspect of the problem has been investigated at the Central

College, and we recommend that rice be soaked for two to three hours at 70° C.

Another essentially needed improvement is the frequent determination of moisture in paddy that is being dried. In American factories, where paddy is cured by certain improved methods of parboiling, moisture determinations are carried out every 15 to 30 minutes on cured paddy that is being dried. It should be noted that the extent of moisture in rice profoundly affects its storage.

A defect of parboiled rice which has been partly responsible for its rather limited popularity, is that parboiled rice when cooked yields a tougher product than that given by raw polished rice. "Tenderness testers" are now being used in food technology in America, to express quantitatively the tenderness of foods. We find that the swelling number (S.N.) can be used as a rough index of the tenderness of the cooked rice. Parboiled rices have S.N. ranging from 240 to 250, while raw polished rices of good cooking quality have swelling numbers ranging from 300 to 320. Parboiled rice, therefore, appears to be an overcured product. By reducing the duration and the temperature of gelatinization of starch, it is practicable to obtain a parboiled rice having a higher swelling number. but the grain will be less hard and there will be a greater loss in milling, due to breakage. We have, therefore, to fix an optimum for the swelling number, taking into account the preference of certain consumers for softness in cooked rice, as also the gain in head rice that is secured by greater gelatinization of the starch.

In recent years, several attempts have been made to modernize the parboiling process, and rice is now cured in America on a large-scale by two patented processes—"Rice Conversion Process" and "Malek Process". These are fundamentally akin to the parboiling process used in India for ages. The swelling numbers of several samples of American converted rice were determined at the Central College, and found to be even smaller than those of parboiled rices of India. Consumers' tests on converted rice were carried out in India recently, on a fairly large scale, under the auspices of the Ministry of Food. It was generally felt that converted rice, on cooking did not yield a sufficiently soft product acceptable to consumers in India, accustomed to raw, polished rice.

Calcured Rice

In an endeavour to obtain a form of cured rice that has the appearance of raw, polished rice. as also its cooking quality, while having at the same time all the desirable features of parboiled rice, a modified process of curing rice has been developed at the Central College. In this process, the paddy is soaked for 2 hours in a dilute solution (0·2 molar) of calcium chloride at 70° C., the pH of which is adjusted to 4·5. The solution is drained off, and the gelatinization of the starch is effected by heating the paddy with steam to a temperature of 98° C. The paddy is then dried and husked. In this process, the gelatinization of starch is carried out to a very moderate extent. the necessary rigidity in structure of the grain being secured by the employment of calcium ion to modify the colloidal properties of starch and of the protein. When rice is soaked in calcium chloride solution, there is an exchange of cations, the potassium in the rice partially goes into solution and is replaced by calcium. The colloidal properties of starch also are modified by calcium ion.

In the calcuring process, the gelatinisation of starch is so adjusted that there is no appreciable fall in the swelling number of the rice. Calcured rice, when cooked, is soft unlike other forms of cured rice. Each cooked grain, however, retains its individuality. The cooked rice has no objectionable flavour. The calcium content of calcured rice is about five times that of ordinary, raw polished rice. There is thus some nutritional improvement owing to higher calcium content.

The thiamin content of calcured rice is on an average 2·3 micrograms per gram of the cereal. The thiamin value can no doubt be increased by soaking for a longer period but this would adversely affect the appearance of the calcured rice. The loss in thiamin on washing calcured rice is 4 to 5 per cent. as compared with the 8 per cent. loss sustained by parboiled rice and 60 per cent. by raw polished rice. Calcured rice is also much less susceptible to insect attack than parboiled rice or raw rice. It is not, however, clear yet how the calcium modifies the rice to make it less susceptible to insect attack.

Dielectric heating for drying cured paddy, though successful, is not economically practicable. This has been found to be very advantageous in the gelatinisation of the starch because of the greater uniformity in heating and of the greater fixation of thiamin in the endosperm. In small-scale experiments, 2·7 μg of thiamin per gram of rice were fixed, while ordinary heat treatment under identical conditions yielded calcured rice having 2·3 μg of thiamin per gram.

The question may now be considered: What is the best form in which rice can be supplied to the consumer? The Rice Study Group of the FAO has recommended that "a large percentage of the rice supply should be parboiled, since such rice keeps in good condition for longer periods"; and that "the consumption of parboiled rice or rice treated by similar methods and having higher nutritive value should be encouraged by governments, since such rice has distinct advantages over lightly milled or hand-pounded rice". In India nearly 60 per cent. of the rice consumed seems to be in the parboiled form. but parboiled rice is not at all popular in several Asian countries. No doubt, many people accustomed to raw rice have, during the present shortage of this cereal, changed over to parboiled rice. But it is debatable how far the changeover is of a lasting character.

Williams advocates mixing with raw polished rice. prior to its cooking, a small quantity of specially treated rice, very rich in vitamins. Until India is in a position to manufacture the synthetic vitamins used in fortification of rice. this method of rectifying the nutritional defects of raw polished rice is scarcely to be commended. The proper solution seems to be a process which renders parboiled rice more attractive in appearance and in flavour.

K. S. R.

Note. The cost of printing this article has been met from a generous grant-in-aid from the Indian Council of Agricultual Research, New Delhi.

PHYSICS OF THE BOTTOM LAYERS OF THE ATMOSPHERE*

THE Physics of the Upper Atmosphere has been dealt with more than once by previous Presidents of this Section. On this occasion, I propose to make a rapid survey of some of the problems concerning the Bottom Layers of our Atmosphere and the Soil Layers immediately in contact with them. Weather is a three-dimensional problem, and to understand it fully one must explore the whole atmosphere. The troposphere, the seat of major weather phenomena, may be treated as a vast thermodynamic Heat Engine with water vapour as the working substance. Although every branch of classical and modern physics has the fullest scope for enquiry and research in the atmosphere around the earth, I confine myself here, as far as possible, to some of the happenings near the base of the atmosphere.

Radiation

When solar radiation passes through the atmosphere it is depleted by the processes of (1) absorption by certain components of the air, (2) molecular scattering by air molecules and (3) scattering by dust and other impurities. Solar radiation is absorbed by the oxygen, ozone, carbon dioxide and water vapour in the air but the most conspicuous is absorption in the near infra-red by water vapour and in the extreme ultraviolet by ozone. The last mentioned is of immense significance to life on the surface of the earth, as these radiations are very injurious except in minute doses.

The blue colour of the sky is due to the preferential scattering of shorter wave-lengths by the air molecules. Owing to paucity of actual radiation data in India (limited data are only available for Poona and Shajahanpur) computations have been undertaken for various latitudes over India on the basis of Bouquer's equation.

The total hemispherical radiation emitted by the earth's surface (0·669 gr. calories/cm.^{2}/mnt.) is comparable to the direct radiation (2 gr. calories/cm.^{2}/mnt.) from the sun at the upper limit of the atmosphere. In the disposal of the thermal radiation emitted by the earth's surface, water vapour in the troposphere, CO_2 which occurs throughout the atmosphere and ozone in the upper air play a significant part.

Thus the absorbing components like ozone, CO_2 and water vapour absorb the direct radiation from the sun and the thermal radiation from the earth's surface and also emit heat radiation in the wave-lengths that they absorb. It is important to know the exact distribution of the absorption coefficients with wave-length for the entire spectrum in order to evaluate the radiative equilibrium in different parts of the atmosphere. Our knowledge of absorption coefficients is incomplete and requires further thorough investigation of the absorption spectra of various gases at various temperatures and pressures.

In India, investigations on atmospheric radiation were commenced in 1930 by Ramanathan who was the first to give a complete picture of the thermal structure of the earth's atmosphere and to have conducted extensive measurements of ozone distribution in the upper atmosphere over India. Several workers have since continued radiation work mainly at Poona. Ramanathan's thermal picture brings out the interesting fact that the troposphere is highest and the air coolest just above the equator.

Phenomena Near the Ground

Coming to the base of the atmosphere which is comparatively easier to investigate, one has to remember that insolation is the most important factor governing the climate of the air and soil layers near the ground. Workers at Poona have taken experimental measurements of this factor under various conditions. The surface of the ground is an "active surface" as it absorbs solar radiation and thereby warms the air and soil layers near it, and its absorbing power depends on the colour of the soil. The insolational heating and radiational cooling of the ground are propagated upwards into the airlayers and downwards into the soil layers. The diurnal range of temperature is maximum at the ground and decreases in the soil very rapidly with depth, becoming negligible at 1 foot or more. In air layers, the range falls rapidly in the first few inches and more gradually aloft, becoming negligible several kilometers above the ground as against 1 foot in the soil. Theoretical as well as experimental work of Malurkar and Ramdas in 1930 have enabled a clear understanding of the convection processes near a hot surface. The temperature at the soil surface can be as high as 75 to 80° C., and the lapse rate in the first cm. or two, 200,000 times the adiabatic lapse rate. The processes involved in the nocturnal cooling of the ground and the airlayers near it, the temperature fluctuations and the turbulence in the air layers near the ground have been studied at the Central Agric. Met. Observatory at Poona. A complete picture of the growth and destruction of the thermal inversion layer near the ground has also been given for the first time as a result of work at Poona, and is based on temperature readings taken with an Assmann Psychrometer at short height intervals. These measurements have also shown that the time lag of the maximum temperature epoch as one moves away from the ground is much larger than should be the case if the conduction close to the ground was truly molecular. Considerable work has also been done at Poona on the transmission of heat by convection from insolated ground to the atmosphere and on the exchange of water vapour between the soil and the air layers. Soil samples containing only hygroscopic moisture, exposed in the open, lose water by evaporation from the morning up to the maximum temperature epoch, and thereafter the soil reabsorbs the water vapour from the atmosphere. There is a complementary phenomenon going on in the air layers near the ground. During the day there is an upward

* Extracts from the Presidential Address delivered by Dr. L. A. Ramdas at the Physics Section of the Indian Science Congress, at Patna, 1948.

flow of water vapour from the ground, vapour pressure decreasing with height; at night vapour pressure increases with height.

The thermal balance at the ground surface is controlled by radiation, convection, conduction and evaporation. Calculation on the basis of experimental measurements at Poona on 23rd April 1936 showed a gain of 1366 and loss of 1355 gr. calories per sq. cm., resulting in a carry-over of 11 calories to the next day.

Micro-Climates of Plant Communities: Investigations at Poona show that plant communities tend to develop their own characteristic local or micro-climates which deviate from the climate of a neighbouring open space to the extent that horizontal air movement and incidence of solar radiation are cut off by the stand of the crop. The state of the ground also plays its part. Inside the sugarcane crop the almost continuous canopy of foliage acts like an *active surface*, and during the day, the canopy gets warmer than the ground, and forms a 'forced inversion'. Micro-climates of plant communities and their variation with age and density of crops are of great interest to agriculture.

Problems of Hydrology: The Agric. Met. Section at Poona has also been investigating the movement of moisture through soil, evaporation from free water and soil surfaces, effects of salts on permeability of soils to water, etc. Problems relating to the evaporating power of air layers near the ground, the fate of rainfall on irrigation, which is controlled by various factors like drainage, percolation, etc., have been studied on the basis of experimental measurements. The results of these experiments are of obvious importance to indigenous agriculture.

B. N. Srinivasiah.

* The cost of printing this article has been met from a generous grant-in-aid from the Indian Council of Agricultural Research, New Delhi.

THE PLACE OF BIOCHEMISTRY IN INDIA*

EVERY student of Biochemistry knows what tremendous amount of literature has been produced during the last two decades on the subjects of vitamins, hormones and enzymes.

The role of vitamins in the alleviation of disease, and the eradication of such plagues as beri-beri, scurvy, pellagra, which took an enormous toll of life in many parts of this earth, was important enough to justify the support which this study obtained in different laboratories of the world. The biological significance of these chemical substances went, however, much further. Many conditions of obscure ætiology, and in apparently normal individuals, a feeling of vague illness, proved to be due to a deficiency of one or the other vitamin, and yielded readily to vitamin therapy. Thus vitamin therapy became popular for the promotion of optimum health with considerable success.

Coming to the subject of hormones, this field has not lagged behind that of vitamins, in the prolificity of literature, the importance of its discoveries and their application to human problems. In fact the output of papers has been so prolific in this field that new journals were founded to publish researches in endocrinology. Taking the group of sex hormones alone, it is well known how the biochemistry of these developed rapidly after the isolation of Oestrone by Doisy and by Butenandt in 1929 from human pregnancy urine. In less than a decade the entire group of naturally occurring œstrogenic and androgenic compounds and progesterones were isolated, their chemical structure and the laboratory synthesis of some of them worked out. The physiological action of these compounds, their biosynthesis, their metabolism and their role in pregnancy, reproduction, lactation, growth, puberty, senility are subjects of profound human interest, and biochemistry has enriched our knowledge of these remarkably. Researches on hormones have also led to the discovery of new techniques both in chemistry and clinical medicine. In the latter field, the nature of sex determination, sex involution, pubertal growth have been delineated experimentally with the help of these hormones.

The possibility of cholesterol being the starting point of the biosynthesis of steroid hormones was indicated by Fieser and by Koch in their admirable monographs. Recent studies of Bloch with the help of deuterium-containing cholesterol have provided an experimental support for this view. The administration of this cholesterol led to the appearance of deuterium containing pregnandiol in pregnancy urine. The output was of the order expected. Discoveries of fundamental importance are likely to result from a study of the role of hormones in cell processes which are being actively pursued to-day. The action of androgens in the synthesis of proteins, and of adrenal cortex steroids in the metabolism of carbohydrates, proteins and salts are already well established.

Enzymology is another fruitful field which biochemistry has explored with admirable success. While the foundations of this study were laid almost in the middle of the last century by the work of Liebig and Pasteur on fermentation, it is only during the last two decades that we have been able to get a clearer glimpse of the myriads of chemical reactions taking place in the tiny living cell. These chemical reactions which are collectively referred to as intermediary metabolism and whose integrated systems are responsible for all the phenomena of life, are not spontaneous, but organised and well-controlled processes brought about by highly specialised catalysts, the enzymes. Since the number of chemical reactions in a tiny living

* Extract of the Presidential Address to the Section of Physiology, by Dr. Bashir Ahmad, at the 35th session of the Indian Science Congress, in January 1948, at Patna.

cell are to be counted in hundreds, it supposes the presence of hundreds of enzymes. This, in fact, is true, and literally hundreds of enzymes have been isolated from the small yeast cell.

One of the most remarkable achievements of biochemistry in the field of enzymes is the reconstruction of the entire process of the fermentation of glucose to alcohol and glucose to lactic acid *in vitro*. Some twenty enzymes are involved which have been isolated and prepared in a pure state. A complete picture has been produced of the chemical details of how the various enzyme systems are linked and how the different chemical reactions are synchronised. This indeed is a remarkable achievement, but it is a drop in the ocean. Vast fields of virgin territory remain unexplored in enzyme chemistry.

Some other landmarks in the field of enzymes are the elucidation of the chemical nature of cozymase by Euler and his school (1937); of cocarboxylase by Lohman and Schuster (1937); of the yellow enzyme of Warburg by Warburg himself and by Kuhn (1935) and Karrer (1935); of the enzyme of tyrosine decarboxylase by Gunsalus (1944); all of which are examples of vitamins functioning as prosthetic groups. These explain the organism's continuous requirement of vitamins. Similarly the indispensability of certain trace elements in nutrition point to their being parts of some important enzyme systems. The development of the knowledge of enzyme chemistry also provides a basis for the understanding of the chemotherapeutic action of drugs. Observations on the relation of sulphonamides and *p*-aminobenzoic acid are important landmarks in this direction. These support the view that sulphonamides only compete with *p*-amino-benzoic acid in the formation of an essential enzyme complex. The action is not unlike that of an anti-vitamin. For the first time these studies open up an important avenue for a rational programme of chemotherapeutic research after many decades of much wasteful effort in organic synthesis.

Fundamental knowledge of plant biochemistry is essential to the plant pathologist, the plant geneticist. the horticulturist, and the economic botanist. This knowledge has grown into an important branch, though not as far developed as animal or bacterial biochemistry. The course of biochemical reactions in the plant are somewhat more complex than in the animal. Starting from carbon dioxide, water and a few inorganic elements, the plant cells synthesise an extraordinary range of complex organic compounds providing complete systems of synthesis and break down within themselves. Plant tissues, unfortunately, do not offer the same facilities for study, as the blood, the glands, the liver, or the organs of digestion and excretion in the animal; but new techniques for investigating the complex biochemical systems of plants are being devised which open up avenues of enormous possibilities. For example an enzyme system has been isolated from plants by the help of which starch can be synthesized *in vitro*. Even the enzymic synthesis of sucrose has been accomplished *in vitro*. Though the starting materials in this case were glucose-monophosphate, fructose and an enzyme system obtained from a bacterial organism, a line of attack has been opened which offers possibilities of development.

There are many other important fields in which biochemistry is making contributions of fundamental importance. Mention may be made of genetics, viruses, chemotherapy and immunology. An insight is being gained into the nature of genes and viruses, and how they direct biochemical reactions. The mechanism of the genetic control of the oxidation of homogenetic acid, presumably through a specific enzyme; of the synthesis of plant pigments such as carotinoids, anthocyanins and flavones; and several other oxidations and syntheses in the plant and in the animal are being gradually elucidated. Recent observations on the chemical and genetic mechanism of the reproductive system of *Chlamydomonas*, and of the amino-acid synthesis in *Neurospora* are of great significance. Encouraging investigation have been made on the chemical nature of viruses, and change of their chemical structure by certain chemical reactions. A clearer understanding of the biochemical mechanism of the therapeutic action of drugs is being reached. Chemical nature of the protein antigens and specific polysaccharides, of toxin and antitoxin reactions is being revealed and foundations of the science of immunochemistry laid.

I have picked up and presented to you a few glittering fragments from the large mass of scientific literature in biochemistry and indicated the role which they play in the progress and welfare of man. Biochemistry to-day is no longer the handmaid of medicine, or the ugly duckling of physiology. It is a full-grown science in its own right. Though still young, it has grown in stature bigger than some of the traditional branches. It has already done tremendous service to man, but its unexplored potentialities are even greater.

K. S. R.

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LETTERS TO THE EDITOR

PAGE

The Apparent Shape of the Moonlit Overcast Sky. D. VENKATESWARA RAO .. 19

A Proposed New Component of Solar Radiation. ALFRED B. ARLICK. .. 20

A Bulb-Tube as a Pyknometer. J. W. AIRAN 22

The 2 : 4-Dinitro-phenyl Hydrazine Colour Reaction for Vitamin K. D. V. S. REDDY AND V. SRINIVASAN 22

Influence of Extracts of Germinated Indian Pulses on the Formation of Amylase by Bacillus subtilis. B. S. LULLA .. 23

Effect of Antibiotics on the Milk-Clotting Enzymes of Carica papaya *and* Ficus carica. R. RAGHUNANDANA RAO AND C. R. KRISHNA MURTI 23

Utilization of Desizing Washings for the Culture of Industrially Important Micro-Organisms. B. S. LULLA 24

PAGE

Change in Nitrogen Content of Milk on Souring. S. C. ROY AND D. P. BHATNAGAR 25

Gammexane (D. 025) and Cattle Ticks. B. N. SONI 25

Optically Positive Hypersthene from Charnockites of Guntur District. C. MAHADEVAN AND A. NARASINGARAO .. 25

The Sex Organs of Phytophthora himalayensis *Dastur.* BALAJI D. MUNDKUR .. 26

A Xenostele on Neolitsea zeylanica. M. J. THIRUMALACHAR 26

A Case of Cytomixis in Crotalaria medicaginea *Lamk.* N. SATYANARAYANA RAO .. 27

On Gourami Nests in a Hill Spring and a Rocky Gundam. V. D. SPURGEON .. 28

Young's Modulus—
S. C. OAK 28
V. L. TALEKAR 28

THE APPARENT SHAPE OF THE MOONLIT OVERCAST SKY

IN an earlier note in this *Journal*,[1] the author has reported the measurements of the half-arc angle[2] under various conditions of clouding in the sky during day-time. They led to the anomalous conclusion that the half-arc angle decreases with increasing cloud-height, contrary to what should be expected on a geometrical basis. It was felt worthwhile to investigate whether the behaviour of the half-arc angle would be similar in the case of overcast night skies also. The results of such a study are reported in this article.

In the absence of the moon in the night sky, the clouding in the sky would be indiscernible, and the overcast would appear equally dark to the eye, irrespective of the height of its base. It is, therefore, only on moon-lit nights that such measurements could be carried out. As the intensity of illumination present in the sky may itself influence the half-arc angle to an uncertain degree,[3] measurements were made only on days when the moon was full or nearly so and was sufficiently clear of the horizon so as to illuminate the clouding uniformly. On most of the occasions reported here, the skies were totally overcast and, on the rest, they were nearly so. The times of observation were between 21.00 and 24.00 hrs. I.S.T. The heights of base of cloud were visually estimated. The half-arc angle was measured as before.[2,3] Eight measurements were taken on each occasion in four different directions, and their arithmetical mean was adopted as the representative value.

The results are reproduced in Table I below. In the last column of this table are given the corresponding values of the half-arc angles for the day-time skies, picked up graphically from the measurements of the author[1] and of Miller and Neuberger.[4]

TABLE I

Date	Height of base of cloud in feet	Half-arc angle for full-moon night sky in degrees	Corresponding half-arc angle during day time in degrees
13-6-1946	2,500	22·6	28·6
14-6-1946	3,000	22·8	28·4
9-9-1946	5,000	23·2	27·7
14-7-1946	7,000	23·7	27·4
13-7-1946	10,000	24·7	27·1
9-9-1946	13,000	25·5	26·6
9-9-1946	16,000	26·0	26·3
10-9-1946	22,000	26·5	25·4

The most interesting feature of the above results is that the half-arc angle for the overcast night skies shows an actual increase with increasing cloud-height, quite unlike during day-time. This is in accordance with what may be deduced on a purely geometrical basis. For, if O is the position of the observer, H that of the apparent horizon and Z the zenith, the greater the value of OZ, the higher would be

the half-arc angle for the same value of *OH*. The true explanation is, however, not so simple; for, the situation is complicated by the fact that perception of depth is to a great extent subjective.[3] The thicker and darker a cloud, the more convex does the sky look to the eye. The influence of this subjective impression so far outweighs the geometrical fall of the half-arc angle due to decrease in the height of the cloud-base during day-time that the net effect is one of its actual increase. Such an explanation for this anomaly is justified because, during day-time, the value of *OH* is unaffected by the elevation of the cloud-base and is mainly determined by the existing conditions of visibility. During night-time, on the other hand, when the skies are overcast, due to the prevalence of darkness all round, the apparent value of *OH* would vary subjectively with the illumination that obtains on the furthest fringes of the cloud canopy. The value of *OZ* would similarly depend upon the zenithal luminosity of the overcast. With increasing cloud-height on moon-lit nights, *OH* ond *OZ* would, therefore, vary both objectively and subjectively.

The thicker the cloud during the moon-lit night, the darker it looks both at the zenith as well as near the horizon. This would make the distances of *OH* as well as *OZ* appear equally enhanced. The influence of subjective impression on *OH* may thus almost neutralise that on *OZ*. The variation of the half-arc angle with elevation of cloud-base may, therefore, become effectively objective.

A matter of practical interest that emerges from this study is the usefulness of the results reported here for the determination of the height of base of cloud during moon-lit nights. When the sky is overcast during the night, it is difficult for an observer on the ground, particularly in poor moon-light, to distinguish between different types of clouds and much more so to estimate their heights of base. Experience shows that searchlight observations are not quite possible in the presence of moon-light, as the beam of light fails to sufficiently illuminate the base of the cloud to enable observation from the ground, except when the cloud base is very low and the moon is very feeble. A mere measurement of the half-arc angle would, on such occasions, enable a fairly accurate judgment of the cloud-base. If a graph be drawn between the half-arc angle and the height of cloud-base using the data reported here, the height corresponding to any angle can be easily read off therefrom. Such a graph shows that the relationship between the half-arc angle and the height of the cloud-base is almost linear up to about 15,000 feet.

The usefulness of the above graph is not limited to the overcast full-moon skies only. For some of the measurements made by the author, during the course of his work on the effect of illumination on the apparent shape of the sky, show that the half-arc angle for any overcast sky, when the moon is half is practically the same as when the moon is full. The graph can, therefore, be used for all states of the moon from half to full. Nevertheless, when the sky is thickly overcast with a deep layer of low cloud, the moon-light may so completely be cut off as to render the clouding imperceptible. On such occasions it may not be possible to determine the half-arc angle. But under such conditions, cloud-height can be easily measured by the searchlight method.

The author wishes to thank Mr. B. N. Sreenivasaiah, Meteorologist, Madras, for his kind interest in the work.

Meteorological Office,
St. Thomas' Mount,
Madras, D. VENKATESWARA RAO.
November 17, 1947.

1. Venkateswara Rao, D., *Curr. Sci.*, **1947, 16,** 55. 2. —, *Ibid*, **1946, 15,** 40. 3. —, *Proc. Ind. Acad. Sci.*, **1947, 25, 34.** 4. Miller, A., and Neuberger, H., *Bull. Amer. Met. Soc.*, **1945, 26,** 212.

A PROPOSED NEW COMPONENT OF SOLAR RADIATION

IN a previous communication[1] the author examined variations in the selective absorption of light by molecules of the earth's lower atmosphere in the region of the oxygen absorption bands, and suggested that these were due, in part, to action on the molecules of a high-powered component within the earth's fair-weather electric field.[2] A comparative study of fundamental atmospheric electric phenomena has, however, indicated an additional, possible contributory factor.

In the accompanying comparison diagram are reproduced, with Greenwich mean time as abscissa and a variable ordinate (for which reference should be made to the original papers) the following curves:

(*a*) Curve '*e*' in Fig. 2 of Price and Chapman's[3] estimate of diurnal variations in the non-vanishing, terrestrial magnetic, line-integral current flowing across a representative region of the earth's surface;

(*b*) Curve 7 in Fig. 3 of Hogg's[4] variations in the rate of production of small ions in the lower atmosphere in fair weather;

(*c*) the mean of the electrogram and curve shown in Figs. 3 and 4 respectively of the diurnal variations in the apparent vertical component of the earth current observed by Forbush[5];

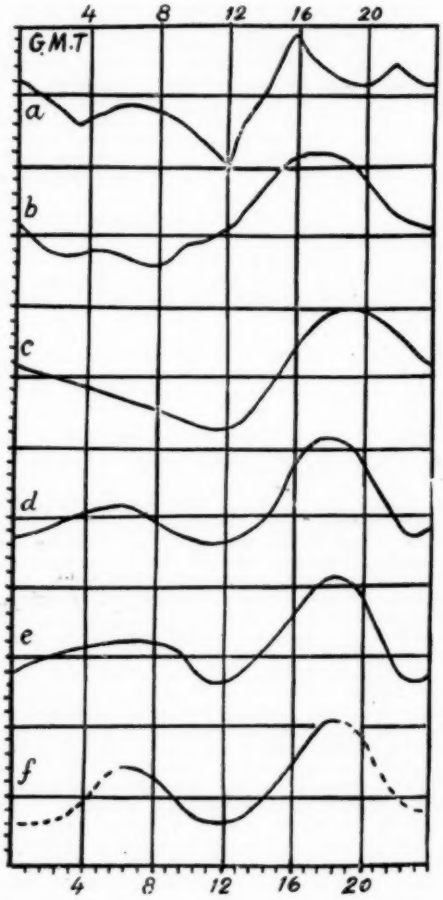
(*d*) curve of variations in the potential gradient of the earth's electric field from a typical. fair-weather electrogram of Colaba Observatory, set to G.M.T.;

(*e*) curve of Medi's[6] observations of day-time variations in atmospheric radiation, placed adjacent to Curve 1 in Fig. 1 of the author's own[7] qualitative observations of night-time variations in atmospheric radiation intensity, particularly in the region of the oxygen absorption bands (the red), the resultant indicating a marked correlation with the atmospheric potential gradient; and

(*f*) a curve constructed from Perot's[8] remarks on daily variations in the frequency of lines in the "B" band of the atmospheric oxygen absorption spectrum.

It will be seen that in every case there is, broadly speaking, a primary minimum in intensity at about noon, and a primary maximum at about 17.00 hours, both by G.M.T. The only

exception is the minimum, in the ionisation curve (*b*) of the diagram, which appears earlier in the day But it must be said here that the Nolans[9] in their estimates of atmospheric ionisation do indeed indicate a primary minimum at noon (see Curve 3 in Fig. 3 of



Comparison diagram accompanying note entitled A proposed New Solar Radiation by A. B. Arlick, Bombay, 20th November 1947.

their paper), besides the main maximum at about 17.00 G.M.T.

Since there is reason to believe that the above widely separated geophysical phenomena are truly representative of local terrestrial conditions, such a parallelism in them may mean that they all have a common origin.

The curve (*d*) also being a manifestation of the earth-to-air supply current, or compensation current, the suggestion of Bauer and others,[10] to the effect that there exists a non-ionizing but highly penetrating corpuscular radiation of extra-terrestrial origin which supplies this compensation current, may be adopted.

On a qualitative survey, it seems possible that a radiation of this kind, in penetrating the lower atmosphere, the earth's surface and upper crust, would cause (*a*) the magnetic line-integral currents by electric convection, (*b*) variations by irradiation or nuclear impact in the γ-ray activity of the atmospheric radon molecule which is the primary cause of ion-formation in the lower atmosphere, (*c*) vertical earth currents of the appropriate sign on penetrating the earth's surface, also by electrical convection, (*d*) changes in the potential gradient of the earth's electric field by progressive replenishment of the earth's escaping negative surface charge, (*e*) variation, by collision processes, in emissive and absorptive atmospheric radiation from the ordinary air molecules, and (*f*) variations, by excitation, in the frequency of lines in the absorption bands of atmospheric oxygen during night. It is, therefore, likely that this radiation provides the common origin and causes the fundamental, fair-weather atmospheric electric phenomena noted above.

Further, since it is well known that the major phenomenon—the earth's potential gradient—varies according to *solar* diurnal time, all the other phenomena man be expected to vary likewise. It is, therefore, clear that the suggested new extra-terrestrial radiation, if it exists, should, directly or indirectly, have its origin on the sun.[11]

While work must first be done on an atmospheric molecule by a strong, applied electrostatic field component (to excite or modify the spectral radiation which it emits or absorbs), according to the electromagnetic theory it would also seem permissible to assume action by collision with particles of a proposed, new radiation of solar origin, in order to account fully for anomalies in the spectrum of the earth's lower atmosphere.

It is hoped to undertake a detailed mathematical analysis of this theory elsewhere, and I wish to express indebtedness to Professor N. R. Tawde for his encouragement and continued interest in this field of geophysics.

Department of Physics,
Royal Institute of Science, ALFRED B. ARLICK.
Mayo Road, Bombay,
November 20, 1947.

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1. Arlick, A. B., *Curr. Sci.*, **1946, 9,** 105. 2. Frenkel, J., *J. Phys. U.S.S.R.*, **1944, 8,** 285. 3. Price, A. T. and Chapman, S., *Proc. Roy. Soc.*, **1928, 119 A,** 188. 4. Hogg, A. R., *Beitr. z. Geoph.*, **1935, 43,** 373 5. Forbush, S. E., *Terr. Mag.*, **1933, 38,** 4. 6. Medi, E., *Ricer. Sci.*, **1938, 2,** 139. 7. Arlick, A. B., *Sci. and Cult.*, **1939, 5,** 62. 8. Perot, A., *Compt. Rend.*, **1915, 160,** 549. 9. Nolan, P. J., and J. J., *Proc. Roy. Irish Acad.*, **1931, 60,** 30. 10. Schweidler, E., *SitzB. Akad. Wise. Wien*, **1946, 149,** 2a, 133-44. 11. Alven, H., *Phys. Rev.* **1947, 72,** 89.

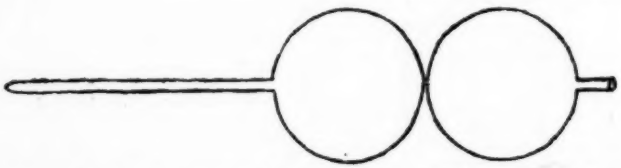
A BULB-TUBE AS A PYKNOMETER

At times it becomes inconvenient to employ the usual type of pyknometer for the determination of specific gravity of liquids which are available in small quantities or when a liquid is either volatile or highly viscous. U-type pyknometers of small capacity may sometimes be helpful. But the removal of air bubbles and the cleaning of the apparatus require special care. Adjustment of the column of the liquid to the given mark at the suction-end involves special effort.

These difficulties are practically overcome if a bulb-tube, as represented below, is used.

The overall length of this bulb-tube may be 6 cm. the nozzle-end alone being 3 cm. The nozzle has a constriction at the end. The two similar spherical bulbs are each 1 cm. in diameter, and connected by a very short and fine capillary tube.

The liquid under investigation is sucked in *via* the nozzle up to the capillary connecting the bulbs.



While weighing in the balance, the bulb-tube may be rested in the pan horizontally on a suitable stool made of metal wire. It is found that the liquid does not flow into the second empty bulb—not at least during the few minutes required for the weighing. A volatile liquid like ether can also be weighed in this apparatus without any appreciable loss due to evaporation at room temperature (25-30° C.). This is further ensured if the suction end is plugged after the liquid has been sucked in. Cleaning does not present a problem even in the case of a highly viscous liquid.

By this method the S.G. for ether is 0·6540 and glycerine 1·2560 at 26°·2, which compares favourably with standard values.

Rajaram College,
Kolhapur, J. W. Airan.
November 5, 1947.

THE 2:4 DINITRO-PHENYL HYDRAZINE COLOUR REACTION FOR VITAMIN K

Of the various colour reactions reported (reviewed by Reddy[1,2] for vitamin K, the 2:4-dinitro-phenyl-hydrazine colour reaction described by Novelle[3] was found to be the most useful because of the high sensitivity and stability of the colour developed. This reaction was found to be applicable to both fat-soluble and water-soluble vitamin K analogues that were available in the market. The following were the products examined:

Trade name	Manufacturer	Chemical nature
1 Kapilin (Injectule)	Glaxo Laboratories	2-Methyl 1:4-naphthaquinone (in oil)
2 Vitamindon K. (Tablets)	Indo-Pharma Pharmaceutical Works, Bombay	Methyl-naphthaquinone
3 Synkamin (Injectule)	Parke Davis & Co.	4-Amino-2-methyl-1-naphthol as hydrochloride (water-soluble)
4 Synkavit (Injectule)	Hoffman La Roche	2-Methyl-1:4-naphthohydroquinone diphosphoric ester as tetrasodium salt (water-soluble)

The green colour was obtained with all these above compounds and the colour was found to be proportional to the concentration of the quinone.

In adopting the technique of Novelle,[3] we experienced great difficulty during the addition of ammonia. Even the slightest excess of ammonia resulted in a reddish-yellow precipitate which masked the green colour. Further one cannot always be sure of the strength of the ammonia especially when the bottle has to be opened often. It was, therefore, considered necessary to study the reaction (especially the effect of pH) in detail and if possible to modify the method.

The green colour was obtained only when the final solution was definitely alkaline. At pH 6·8 a pale green colour was obtained with ammonia but the maximum intensity was obtained only beyond 7·3; but above 7·5 the use of ammonia resulted in a reddish-yellow precipitate. Various buffers and also NaOH in the place of ammonia were tried without success. Sodium carbonate, however, gave more satisfactory results. Even at high pH value Na_2CO_3 did not give rise to the reddish-yellow precipitate, and with this alkali the green colour was obtained only when the final solution was definitely alkaline to thymolphthalein. Further, the colour was quite stable even with excess of Na_2CO_3. Accordingly the following procedure was found to be satisfactory for the estimation of naphthaquinone derivatives, and hence vitamin K, using 2:4 dinitro-phenyl-hydrazine.

(*i*) *Procedure for fat-soluble naphthaquinone derivatives (Kapilin and Vitamindon K)*: 0·5 to 0·15 mgm. of the substance (usually in oil) was shaken up with 0·5 c.c. of ethyl alcohol and to this 0·1 c.c. of a 1 per cent. solution of 2:4-dinitrophenyl-hydrazine in 2 N hydrochloric acid was added. It was then heated in a water-bath at 70° C. for about 10 minutes. It was then cooled, and 0·3 c.c. of a 20 per cent.

solution of Na_2CO_3 was added with shaking followed by 1 c.c. of amyl alcohol and 1 c.c. of distilled water. The green colour separated in the amyl-alcohol layer and could be evaluated in a Lovibond Tintometer.

(ii) *Procedure for water-soluble derivatives (Synkamin and Synkanit)* : 0·5 to 0·15 mgm. of the substance dissolved in 0·5 c.c. of water was treated with 0·1 c.c. of the reagent and heated in a water-bath at 70° C. for about 3 minutes. It was next cooled and 0·3 c.c. of 20 per cent. sodium carbonate solution was added followed by 1 c.c. of amyl alcohol when the green colour separated in the amyl alcohol layer.

This reaction could be used to detect even 0·005 mgm. of the quinone, but a good working range for quantitative work would be 0·05 to 0·15 mgm. of the quinone..

Further work is in progress and a detailed report will be published elsewhere.

Department of Physiology, D. V. S. Reddy.
Madura Medical College, V. Srinivasan.
December 3, 1947.

1. Reddy, D. V. S., *Proc. Indian Sci. Cong.*, **1946, 87.** 2. —, *Medical Digest*, **1945, 13, 239.** 3. Noveile, *Sci.*, **1941, 93, 358.**

INFLUENCE OF EXTRACTS OF GERMINATED INDIAN PULSES ON THE FORMATION OF AMYLASE BY *BACILLUS SUBTILIS*

Raghavendra Rao and Sreenivasaya[1] have shown the possibility of replacing the expensive asparagine, an ideal source of organic nitrogen for micro-organisms, by aqueous extracts of etiolated seedlings of certain Indian pulses that are rich in asparagine. The present work was carried out to determine the overall efficiency of these complex sources of nitrogen on the formations of amylase by *B. subtilis* (N.C.T.C.: 2027 N). The extracts were prepared at different periods of germination (4th, 6th and 8th day), and the results of their analysis were found to concur with those of previous workers.[1] These extracts have been tried,

Table I

Effect of germinated pulse extract on production of Amylase by B. subtilis *with extract containing* 0·5 *mg. nitrogen per* 10 *ml.*

Days after commencement of germination	Enzyme Units per 10 ml. of medium			
	Green gram	Black gram	Bengal gram	Horse gram
4	7·5	8·6	7·9	6·0
6	9·0	12·0	11·4	8·2
8	18·0	15·0	23·7	12·0
With extract containing 1·0 mg. nitrogen per 10 ml.				
4	9·2	10·5	10·0	9·5
6	12·8	18·0	19·8	14·8
8	20·0	21·6	30·0	22·2

by the method already described,[2] at two levels of nitrogen (0·5 and 1·0 mg. in 10 ml. of culture medium). The results are given in Table I.

The results show that, at both levels of nitrogen, the enzyme formed increases steadily with germination during the period of observation. The highest activity is obtained with the Bengal gram extract, both at 1·0 mg. and 0·5 mg. level of nitrogen.

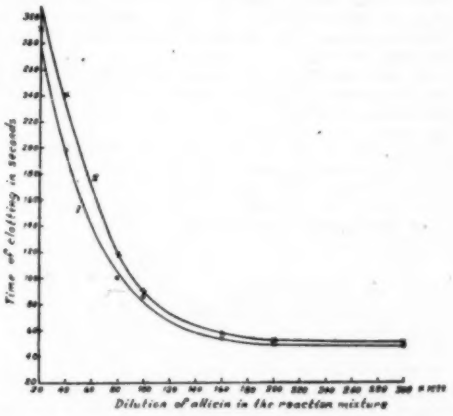
The author's thanks are due to Mr. M. Sreenivasaya and Prof. V. Subrahmanyan for their interest in this investigation.

Section of Fermentation Technology,
(later) Dept. of Biochemistry, B. S. Lulla.
Indian Institute of Science,
Bangalore,
December 12, 1947.

1. Raghavendra Rao and Sreenivasaya, *Curr. Sci.*, **1946, 15, 25.** 2. Lulla, B. S. (reference of the above paper), *Ibid.*, **1948, 17, 2.**

EFFECT OF ANTIBIOTICS ON THE MILK-CLOTTING ENZYMES OF *CARICA PAPAYA* AND *FICUS CARICA*

Several instances of sulphydryl groups inactivating anti-microbial agents have been recorded in literature.[1-6] This has led to the view that the majority of the antibiotics act possibly by reacting with the -SH groupings of enzyme systems in the bacteria. Activation studies using glutathione, cysteine and other thiol compounds, and reversible inhibition by copper and maleic acid support the evidence in favour of the -SH nature of papain[7] and the milk-clotting enzyme of *Ficus carica*.[8] In view of this, it was of interest to study the effect of antibiotics on these enzyme systems.



Curve I after 5 minutes incubation
Curve II after 15 minutes incubation

Different dilutions each of penicillin and allicin were mixed with each enzyme (1:1 v/v),

incubated at 37° C. for different periods and the milk-clotting activities of the mixtures determined.[9] Typical results obtained with penicillin-papain system are presented in Table I.

TABLE I

Inhibition of the milk-clotting activity of papain by Penicillin

Penicillin in O.U. per c.c. (cup plate method)*	Time in seconds for clotting after incubating the mixture for		
	15 minutes	30 minutes	60 minutes
Nil	31	31	31
500	70	111	140
250	54	83	125
100	40	45	50
50	39	41	45
20	32	35	37
10	32	33	34

* The clotting times with the mixtures before incubation were found to be 31 seconds for all the mixtures studied.

Similar results were obtained for the Ficus enzyme-penicillin systems also.

Complete and instantaneous inactivation of the enzymes resulted on incubation with 0·2 mg./c.c. of allicin. When the concentration of the antibiotic was brought gradually to about 3·5 μg, results similar to those for penicillin were obtained. In the accompanying figure, results with allicin and Ficus enzyme are presented.

The above observations confirm the -SH nature of the enzymes studied. Attention has already been drawn to the inhibiting activity of allicin[10] on the starch-splitting activity of β-amylase, which has been shown to be another sulphydryl enzyme.[11] These observations are being extended to other enzyme systems known to play an important role in cell-metabolism.

It is clear that the enzyme-inhibiting activities of antibiotics like allicin even in very high dilutions provides a quick and accurate method for their micro-assay.

Our thanks are due to Prof. V. Subrahmanyan for his active interest in the above work. We acknowledge with gratitude the generous support from the Council of Scientific and Industrial Research, New Delhi.

R. RAGHUNANDANA RAO.
C. R. KRISHNA MURTI.

Dept. of Biochemistry,
Indian Institute of Science,
Bangalore,
December 4, 1947.

1. Cavallito and Bailey, *Sci.*, 1944, **100**, 300. 2. Eagle, *J. Pharm.*, 1939, **66**, 436. 3. Fildes, *Brit. J. Expt. Path.*, 1940, **21**, 67. 4. Atkinson and Stanley, *Australian Journal Expt. Biol and Med. Sc.*, 1943, **21**, 255. 5. Geiger and Conn, *J. Amer. Chem. Soc.*, 1945, **67**, 112. 6. Cavallito *et al.*, *J. Bact.*, 1945, **50**, 61. 7. Ganapathi and Sastri, *Curr. Sci.*, 1940, **9**, 413. 8. Krishna Murti, C. R., *et al.*, *Sci. and Cult.* (under publication). 9. Balls and Hoover, *J. Biol. Chem.*, 1937, **121**, 737. 10. Rao, R R., *et al.*, *J. Sc. Ind. Res.*, 1946, **5B**, 31. 11. Weill, C. E., and Caldwell, M. L., *J Amer. Chem. Soc.*, 1945, **67**, 214.

UTILIZATION OF DESIZING WASHINGS FOR THE CULTURE OF INDUSTRIALLY IMPORTANT MICRO-ORGANISMS

FOR desizing textiles, the common practice is to impregnate the sized cloth with an active amylase solution. After standing overnight the cloth is washed in running water. The washings contain about 1 per cent. sugar besides dextrins and other soluble matter. Our studies in the preparation of bacterial amylase show that the washings could be utilised as a source of carbon for the cultivation of the industrially important micro-organisms.

Bacteria (*B. subtilis*, N.C.T.C., 2027 N), Yeast (*Torula utilis*, N.C.T.C., 3050) and actinomyces (*Actinomyces gresius*, Waksman's strain), which had been previously standardized for amylase formation,[1] food yeast manufacture,[2] and streptomycin production,[3] respectively were employed as test organisms for determining the efficiency of these waste liquids. The cultural conditions for the growth of these organisms were the same, except that the carbon supply in the culture medium was substituted by the equivalent amount of the desized washings on the basis of sugar present. The viscosimetric method* was followed for determining the amylase activity. Yeast growth was observed by Turbidity measurements. The cup assay method, using a susceptible strain of *B. subtilis*, was employed for the assay of streptomycin. The comparative data obtained with the experimental and control media are given in Table I.

TABLE I

B. subtilis		Yeast growth		*Actinomyces gresius*	
Amylase units per 10 ml.* of medium		Galvanometric deflection		Units γ/c.c. on 10th day	
Exptl.	*Contl.*	*Exptl.*	*Contl.*	*Exptl.*	*Contl.*
100·0	120·0	200·0	176·0	100 γ	80 γ

* One Amylase unit is that quantity of enzyme which, acting on a two per cent. starch solution at pH 7·0 and at 40° C., reduces the viscosity by 25 per cent. in 90 minutes.

The results show that the desized waste is a useful source of assimilable form of carbon for the micro-organisms. The difficulty of transporting large volumes of the waste could be considerably reduced either by slightly modifying the process of washing of the desized cloth or by using the washings on the spot.

My sincere thanks are due to Prof. V. Subrahmanyan for his kind encouragement, and guidance in these observations, and to the late Mr. Slicer, Chief Chemist to Bangalore Wool-

len, Cotton and Silk Mills, Ltd., for supplying the desized washings.

Dept. of Biochemistry,
Indian Institute of Science,
Malleswaram P.O., B. S. LULLA.
Bangalore,
December 15, 1947.

1. Lulla, B. S., *Curr. Sci.*, 1947, **16**, 339. 2. D'Souza, V., and Sreenivasaya, M., *J. Sci. Ind. Res.*, 1946 **4**, 647. 3. Waksman, S. A., *J. Am. Pharm. Assn.* (Sci. Ed.), 1945, **34**, 273.

CHANGE IN NITROGEN CONTENT OF MILK ON SOURING

IN this laboratory attempts were made to utilise the estimation of total nitrogen of curdled milk as a criterion of purity of the original milk samples by Kjeldahl Method as suggested by Hawley.[1] A preliminary analysis of about twenty samples on these lines showed that this method is unreliable, inasmuch as the nitrogen content of milk is subject to variation depending on the conditions under which the milk is allowed to curdle and on the initial bacterial flora of the sample.

The following table shows the increase of nitrogen on curdling, in the case of raw buffalo milk kept in different beakers and allowed to curdle in open air at room temperature (average 32° C.).

Days of storage of milk	Acidity (lactic acid %)	Nitrogen (%)	Remarks
0	0·126	0·533	Raw milk before curdling
1	0·815	0·641	After curdling
3	1·56	0·630	"
4	1·75	0·620	"
7	2·08	0·614	"

The main conclusions from experiments carried out under different conditions are :—

1. The nitrogen content of curdled milk is greater than that of the original milk.
2. The nitrogen percentage varies in the same sample of milk at different stages of souring ; it attains a maximum and thereafter tends to decrease.
3. The acidity developed appears to bear little correlation with the nitrogen content.
4. The nitrogen increase appears to be caused by the action of micro-organisms present in the milk.

Since samples of milk are not collected and despatched under aseptic conditions, Hawley's method of evaluating the N_2 content of curdled milk, as a criterion for its purity, cannot be adopted for routine testing.

A detailed paper will be published elsewhere.

Laboratory of the Public Analyst
to the Government, U.P., S. C. ROY.
Lucknow, D. P. BHATNAGAR.
December 19, 1947.

1. Hawley, *Curr. Sci.*, 1937, **5**, 637.

GAMMEXANE (D. 025) AND CATTLE TICKS

A SMALL-SCALE trial with "Gammexane" powder D.025 has been tried on a group of fourteen cattle heavily infested with *Boophilus australis*, a common cattle tick in India. According to the manufacturers, "Gammexane" powder D.025 contains 5 per cent. of pure "Gammexane" (hexachlorocyclohexane) and 95 per cent. of inert diluent such as French chalk or talc. A dozen cattle showing gross infestation with ticks were hand-dressed with the powder. Two animals served as controls. Up to 12 hours after application there was no appreciable destruction of ticks. After nearly 24 hours tick mortality varied from 75-95 per cent. among the treated animals. After 48 hours all the treated animals were tick-free. The residual effect of the drug lasts from 5-9 days, depending on whether the treated animals are sent out for grazing or stall-fed. It is, therefore, necessary that the application should be repeated accordingly. In view of its efficient anti-tick and non-toxic properties and the simplicity of application, the powder could be safely used under Indian conditions.

Indian Veterinary Research Inst.,
Mukteswar-Kumaun, B. N. SONI.
December 1947.

OPTICALLY POSITIVE HYPERSTHENE FROM CHARNOCKITES OF GUNTUR DISTRICT

DURING the course of detailed optical work on the rocks and minerals of the charnockites of the Kondavidu Hills (Latitude 16° 15′ 30″; Longitude 80° 19′), one of the slides of the intermediate charnockites showed a hypersthene with abnormal optical characters. The scheme of pleochroism of this mineral as determined by the Federov's Stage is as follows :—

X : Golden yellowish green.
Y : Light greenish.
Z : Bluish or greyish green.

The only marked difference that this hypersthene shows with the normal type (the usual hypersthene met with in the area) is that the pleochroism along X axis is golden yellowish green here as against pale pink for the normal type.

In one of the hypersthene pieces the extinction is straight and 2 V = 74°, Z being the acute bisectrix. In the other the extinction angle (Z c) is 8° and 2 V = 69°, Z being the acute bisectrix. Thus both these pieces of hypersthene are optically positive. But the normal hypersthene shows the usual negative sign with 2 V ranging from 56° to 66°.

In the chemical analysis of the rock bearing this hypersthene, there is an excess of normative corundum. It is suggested, though it is not asserted, that this anomalous optical character of this hypersthene may be due to an aluminous variety of the mineral. Further work on the mineral is in progress, and a detailed paper will be published elsewhere.

Geology Department, C. MAHADEVAN.
Andhra University, A. NARASINGARAO.
Waltair,
December 23, 1947.

THE SEX ORGANS OF *PHYTOPHTHORA HIMALAYENSIS* DASTUR

THE genus *Phytophthora* de Bary has been given, in spite of the unique mode of sexual reproduction in a section of its members—the amphygynous group—scant cytological attention in comparison with several other genera of the Peronosporales. The only thorough study of an amphigynous *Phytophthora* made so far is that of Murphy[1] on *P. erythroseptica* Pethyb. who advanced arguments to show that there is a piercing of the antheridium by an oogonial incept during copulation.

It has been claimed by some workers, however, that the amphigynous relation of the sex organs is an illusion resulting from an encircling of the female by the male gametangium, and that there is no actual penetration of the antheridium.

In an investigation into the morphology and cytology of development of the sex organs of a new species of *Phytophthora*, *P. himalayensis* Dastur,[2] I have observed that amphigyny, as the term is generally understood, is no artefact and that the oogonial incept does actually penetrate the antheridium.

Nuclear behaviour in *P. himalayensis* follows essentially the same sequence of events as that recorded by Murphy for *P. erythroseptica*. A stage in nuclear development, unique in the Oomycetæ and first described in *P. erythroseptica*, has also been observed in *P. himalayensis*. This particular stage of development has the basal region of the oogonial cytoplasm stratified in arcs of concentric circles whose centre lies somewhere in the oogonial stipe, while the cytoplasm at the distal (apical) region of the oogonium is non-stratified. The nuclei in the stratified region of the cytoplasm are linear or bow-shaped and oriented tangentially in relation to the stratifications, and occur in invariable association with the latter. The nuclei at the distal, non-stratified region are spherical like the nuclei at all other stages of development of the sex organs (Fig. 1).

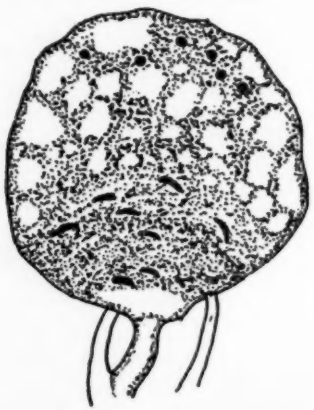


FIG. 1

Murphy regarded the elongate nuclei as eventually transforming into the spherical. In my opinion, the linear form of the oogonial nuclei is due to the pressure exerted on them owing to their characteristic association with cytoplasmic strata which result from regular differences in density of the proximal oogonial cytoplasm.

A curious feature in the morphology of *P. himalayensis* is the development of short, tubular protrusions from antheridia.

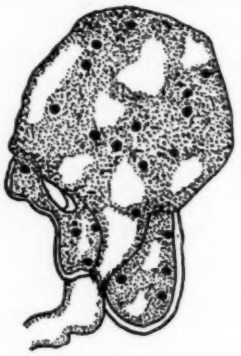


FIG. 2

These antheridial papillæ have not been observed in all copulating gametangia. Each antheridium, in which such papillæ have been observed, generally puts out one protrusion, rarely two or three at a time. Similar papillæ, also observed in *P. erythroseptica* by Murphy were believed by him to function in easing the pressure developed within the antheridium as a result of penetration of the latter by an oogonial incept. My observations do not bear out the function ascribed to them by Murphy. Rather, they serve as fertilization tubes much as the antheridia of paragynous Phytophthoras; owing to the origin of such papillæ from amphigynous antheridia and their homology with paragynous antheridia, such a type of gametangial copulation demonstrates the fundamental similarity of paragyny and amphigyny.

A detailed discussion of the ontogeny of the sex organs of *P. himalayensis* will be published later.

I am grateful to Prof. J. F. Dastur for help in the preparation of this note.

Indian Agric. Res. Institute,
New Delhi, BALAJI D. MUNDKUR.
September 1, 1947.

1. Murphy, P. A., *Ann. Bot.*, 1918, **32**. 2. Dastur, J. F. (in press).

A XENOSTELE ON *NEOLITSEA ZEYLANICA*

COLLECTIONS of rusted branches and leaves of *Neolitsea zeylanica* Merr. were collected from near Ootacamund, South India. Field observations indicated that the rust had broken out in an epiphytotic form. A detailed examination revealed that the rust is a species of *Xeno-*

stele Syd. and agreed in all features with *X. neolitseæ* Ramak. and Ramak., described recently by Ramakrishnan and Ramakrishnan[1] on the same host species from the same locality. The rust forms conspicuous galls on the leaves and young twigs. Only telia were noticed for the rust. Most of the morphological details have been given by the above authors. It might be mentioned that the teliospores are pedicellate, developing in clusters.

Ramakrishnan and Ramakrishnan state, "two species of this genus have been recorded—*X. echinacea* (Berk.) Syd. on *Actinodaphne molochina* in Ceylon, and *X. litseæ* (Pat.) Syd. on *Litsea glauca* in Japan". They were evidently unaware of the fact that *X. Neolitseæ* Teng was described by Teng[2] on *Neolitsea* and that Hiratsuka and Yoshinaga[3] reported *X. nakanoi* (Kusano and Yoshinaga) Hiratsuka and Yoshinaga on three Lauraceous hosts including *Neolitsea aciculata*. The latter is an opsis rust with peridiate æcia and telia.

Only telia are known for *X. neolitseæ* Teng., where the sori are 144-180 μ broad as against 350-400 μ of the present rust. The teliospores are slightly shorter and broader in the Indian species (40-55 × 24-30 μ as against 45-65 × 19-24 μ in *X. neolitseæ* Teng.). The comparatively large telia taken along with the slight differences in the sizes of the teliospores in the Xenostele species under study might be used to separate it from *X. neolitseæ* Teng. Since the specific epithet, *Neolitseæ*, has been used by Teng for a rust distinctly separate from the one under study, the name *Xenostele indica* Thirumalachar nom. nov. is proposed for the Indian species.

Dept. of Plant Pathology,
University of Wisconsin,
Madison, Wis., M. J. THIRUMALACHAR.
November 30, 1947.

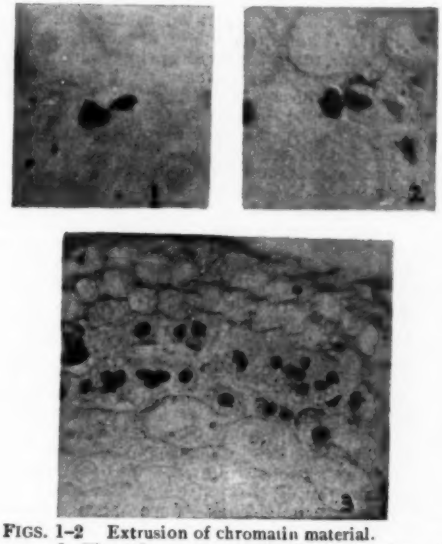
1. Ramakrishnan, T. S., and Ramakrishnan, K., *Proc. Ind. Acad. Sci.*, 1947, **25**, 28. 2. Teng, S. C., *Sinensia*, 1940, **2**, 105. 3. Hiratsuka, N., and Yoshinaga, *Mem. Tottari Agr. Coll.*, 1935, No. **2**, 284.

A CASE OF CYTOMIXIS IN *CROTALARIA MEDICAGINEA* LAMK.

THE chromosome number of *Crotalaria medicaginea* Lamk. only has been reported by Sundar Rao,[1] as $2n = 16$. For further details, a cytological study of *C. medicaginea* has been undertaken.

In some root tips, with periblem cells 2-3 thick, situated 3 or 4 layers below the dermatogen remain more deeply stained even after prolonged destaining. In such cells the chromatin material has migrated into the adjacent cells through protoplasmic connections (Figs. 1, 2) resulting in uninucleate cells (Fig. 3). The migrated chromatin material is more deeply stained than the rest of the cell. Cytomixis,[2] as it is termed, is not peculiar to any particular stage, but is reported to occur in all stages of division of p.m.c., *viz.*, in interkinesis[3] both divisions,[4] and in the resting stage.[5] In root tips, however, only two cases have been reported so far by Jacob in *Clitoria ternata*[6] and in cotton.[7]

Gates[2] considers that the conspicuous openings or connections between p.m.c., allow an equalisation of pressure in the mother-cells



FIGS. 1-2 Extrusion of chromatin material.
1. Through one protoplasmic connection, 2. two connections.
FIG. 3. Multinucleate cells in periblem region, a result of cytomixis.

from one end of the anther to the other. The movement of the nuclei towards the periphery and the nuclear extrusion are believed to occur in connection with this pressure-equalisation. This process is observed more frequently in the chloralised cells than in the normal p.m.c. of *Vicia faba*.[8] Cytomixis is reported to result in abnormalities like increased chromosome number, as in rice[9] and in disintegration of *Triticum* and *Aegilops*,[10] and disintegration of cells.

Though the continuity of affected cells as a ring in the root tip of *C. medicaginea* supports the idea of pressure-equalisation, this 'pressure' seems to arise as an abnormality, as is evidenced by the presence of isolated single or groups of cells in the plerome. In this case cytomixis appears to be pathological, leading to disintegration of cells.

The chromosome number is also determined in mitosis and meiosis and is found to be 16 and 8 respectively as reported previously.[1]

I am thankful to Prof. N. K. Tiwari for his helpful suggestions in preparing this note.

Pithapuram, N. SATYANARAYANA RAO.
December 6, 1947.

1. Sundar Rao, V., *Indian J. Genet. and Pl. Breeding*, 1943, **3**, 64. 2. Gates, R. R., *Ann. Bot.*, 1911, **25**, 909. 3. Gates, R. R., and Rees, E. M., *Ibid*, 1921, **35**, 365. 4. Iyengar, N. K., *Ibtid.*, 1939, **3**, 275. 5. Mensinka, S. W., *J. Genet.*, 1940, **39**, 1. 6. Jacob, K. T., *Ann. Bot.*, 1940, **4**, 201. 7. —, *Curr. Sci.*, 1941, **10**, 174. 8. Sakamura, T., *J. College. Sci. Imp. Univ.*, Tokyo, 1920, **33**, 1. 9. Nandi, H. K., *J. Genet.*, 1936, **33**, 315. 10. Kihara, H., and Lilienfield, F., *Jap. J. Genet.*, 1934, **10**, 1.

ON GOURAMI NESTS IN A HILL SPRING AND A ROCKY GUNDAM

WITH the scanty rainfall and sparsely scattered waters, acquiculture in the Ceded Districts has to be confined to a limited number of suitable waters. The Nalla malai area in Kurnool is dotted with many natural springs and rocky tanks. Attempts at Gourami culture in such waters were successful, and some interesting observations could be made on gourami nests in a typical hill-spring and a rocky "gundam".

The Chagalamarri spring off Nandyal-Cuddapah road was stocked with half a dozen one-foot gourami in November 1944, and *Chara* and Bulrush were planted in the centre and along the margins respectively. In June 1945 two nests were observed in a quiet corner, away from the springs and the main flow. The location of the nest outside the action of the current is not perhaps accidental.

The "Kamini gundam" at Panyam is a fairly large tank. The "gundam" was devoid of macrophytic growth, specially after de-weeding. Even the margin was bare except for some short grass. Yet, on 10th of March 1946, a big-sized nest, made up of neem and bombax leaves, with gourami eggs was seen drifting on the surface. Careful observation revealed that the parents closely followed the nest as it drifted from place to place. After about ten days healthy hatchlings were seen moving about. It was thus seen that though the nest got freed and drifted about, the gourami kept on the parental care and the drifting condition of the nest did not interfere with the incubation of the eggs.

My thanks are due to the Director of Industries and Commerce, Madras, for kindly permitting this note to be published and to Dr. T. J. Job for helpful suggestions in preparing this note.

Pearl and Chank Fisheries,
Tuticorin, V. D. SPURGEON.
August 30, 1947.

YOUNG'S MODULUS

MR. V. L. TALEKAR has described[1] a method for determining Young's modulus for materials.

He has pointed out that so far only mechanical methods have been used for this purpose, and claims that his method of determining Y by electromagnetic and interferrometric measurements would be simpler in comparison with the traditional method.

This seems hardly plausible since his method involves measurements of electric currents, magnetic fields and small distances with the help of interferrometer, in addition to the usual measurements of length and diameter of the specimen.

He has also neglected the geometrical properties of the metallic ring to be tested as well as the effect of heating by electric current on the elasticity of the specimen.

In short, it is doubtful if the novelty alone can in any way recommend the adoption of his method in preference to the traditional one.

7-A, Vissonji Park,
Naigaum Cross Road, S. C. OAK.
Dadar, Bombay 14,
December 29, 1947.

1. Talekar, V. L., *Curr. Sci.*, 1947, **16**, 337.

THE idea in giving this method is not to replace the traditional one as Mr. Oak has mentioned; but to provide an additional one. It is easy to see that due to very low resistances of metals and the small size of the ring, there will be hardiy any heating of the specimen. The quantities involved can easily be measured in a scale suitably equipped and should not present any difficulty as envisaged by Mr. Oak. The method is being worked by the author.

Dungar College,
Bikaner, V. L. TALEKAR.
January 14, 1948.

NEW THEORY OF SMELL

WAVES comparable to those of light and radio but carrying smells are the essence of a new theory of the olfactory mechanism, developed and tested experimentally by scientists of Yale University, New Haven, Connecticut. The theory relates the sense of smelling to that of light rather than to chemical processes which were formerly believed to be responsible for the faculty of smelling.

The new theory endows the nose with remarkable and strange facilities, operating on a principle resembling the emission and echo reflection that make radar a miraculous detection instrument. According to the theory, the human nose is but a house for a set of antennæ —the tiny hairs in the nasal cavity just behind the point where eyebrows and the nose-bridge meet. This olfactory organ sends out an array of wavelengths, all within an octave in the infra-red range of the spectrum, rich in radiation from complex chemical substances.

In the nose's particular waveband, called the *osmic range*, tiny wave-beams are sent out to each substance to be smelled. Some of the beams will be absorbed, but others will be reflected, depending on the molecular structure of the substance. This reflected infra-red radiation returns to the nose. There this 'echo' finds a dense mass of nerve endings in the dark parts of the nasal membrane, rivalling in complexity and sensitivity the retina of the eye. These nerves are the receivers of smell, placed under protection so that an abundance of smells would not become confusing.

Under the new theory, smelling is an energy-resonance phenomenon which gives the nose the new name of osmic-radiation receiver. The transmitter-receiver combination locked in the nose operates on wavelengths ranging between 80 000 and 140,000 Angstrom units, compared to 4 000 (violet) to 8,000 (red) units for visible light.

The theory came into being through experiments with insects such as roaches and bees which smell with their feelers. Most startling was the experiment with a rare species of moths. Marked males were released from a train each mile up to seven miles distance. A few hours later the males had found their way back to a female, kept in an hermetically closed glass tube at the point of the train's departure.—*USIS*.

REVIEWS

Qualitative Analysis by Spot Tests—Inorganic and Organic Applications. By Fritz Fiegl. Third, completely revised English edition, translated by Ralph E. Oesper. (Elsevier Publishing Co., Inc., New York, Amsterdam), 1946. Pp. 574 + xvi. Price $8.00.

The first English edition of the book appeared in 1937 and the second in 1939, the latter translated from the third German edition. Several reprints of the second translated edition were issued. Now, with the return of peace, the third edition—the one under review—has been brought out. The frequency with which several editions of a book and numerous impressions of the same edition appear, undoubtedly speaks of the demand for the popularity of the book.

Analytical chemistry is an unobtrusive branch of chemistry with few flowers and hardly any fruit. It attracts few votaries, as its pursuit seldom yields spectacular results. Yet those ardent few who more than nibble at this branch sometimes lay foundations in chemistry as firm and permanent as those others who gave it its laws. That is what is exceptionally revealed by a study of the 'art' which Feigl has almost made his own and made known through the pages of his book.

In a book of practical nature where nothing can be irrelevant nor redundant, the summary of its contents is best given by quoting relevant portions from the author's preface. Here it is. "The present edition includes the newer spot reactions, together with details of the pertinent procedure and applicatinos. ... The author has tried to assemble and present the entire literature on spot test analysis in such form that the reader will be able to secure here a rapid survey of the available spot tests and their applications. Tested directions for carrying out the tests are of course an integral part of the text."

Among the several other features is a new chapter: "Working methods and special aids" included to give a complete picture of all the phases of spot test analysis.

Further appraiement of the book leads to commenting on the general methods of spot test analysis itself. The new scheme of analysis could not be said to be yet as perfect as the classical methods of qualitative analysis, inorganic or organic. Because the classical analysis is systematised and rather simple, it is usually easy to get familiar with its methods. But it is quite different with the tests prescribed in the book. Each of these tests is so specific for a particular radicle or group that in its application one must have a prior knowledge, at least approximate, of the constituents of test mixture. Chapter V provides but a partial remedy to this. The science is comparatively recent, and it is as yet too early to say whether these new methods of analysis would supplant, if even, the classical systematic methods of qualitative analysis. Even in its present limited role of being a supplement to the classical methods, the 'spot' test is already proving to be a very potent weapon in the armory of the analytical chemist. But the technique is very special; and only those versed in it can wield it, and the book helps one in this respect.

S. N.

Trace Elements in Plants and Animals. By W. Stiles, Mason Professor of Botany in the University of Birmingham. (The Cambridge University Press), 1946. Pp. xii + 189. Price 12*sh.* 6*d.*

Although Mazé gave a fillip to the trace element problem as early as 1914, through demonstrating the sources of errors inherent in the experiments and suggesting precautionary measures, the work did not proceed far, as no sensitive methods of estimation of "traces" were then available. It is only during the last decade that the problem has progressed by leaps and bounds with the development of physical instruments, such as the absorptiometer, the polarograph, and the spectrograph, and chemical techniques such as the Dithiozone method. Since the discovery of their importance in the so-called physiological diseases, the trace elements have engaged the interest of not only the plant physiologist but also the plant pathologist, the veterinary surgeon, the agriculturist and the horticulturist. In fact the work done in recent years is so bewilderingly enormous that a masterly résumé on the subject has been very much needed. In bringing forth the book, therefore, Professor Stiles is catering for the earnest demands of both the erudite and the beginner.

After a brief historical introduction, the author proceeds to discuss at length the methods of purification of materials and estimation of micronutrients and the diagnosis of deficiencies are very informative to the investigator. A full chapter is set apart for the diseases of various economically important plants caused by the deficiencies of Mn, Zn, B, Cu and Mo. The difficulties encountered in diagnosis and treatment are well discussed. The chapter on the function of trace elements in plants critically reviews the entire work done in this field. The comparatively meagre progress achieved in the case of animals is dealt with in a separate chapter. The function of trace elements in general in the metabolism of animals are still obscure and the discovery that Cu and Zn are associated with proteins and enzymes as prosthetic groups may help to throw light on the role of other elements also.

The book, giving all the available facts and outlining ways for future research, will be very useful to one and all interested in the subject.

S. R. ASWATHA NARAYANA RAO.

An Introduction to Textile Finishing. By J. T. Marsh. (Chapman and Hall, London). Pp. 552. Price 35*sh.* net.

Finishing of textile goods has been in the vanguard of post-war developments in Textile Technology as revealed by the numerous processes and patents recorded in current technical literature, and Mr. Marsh set himself a

formidable task in attempting "to survey finishing as a whole" (p. 393), but has successfully accomplished it in this publication. He has rendered signal service to the science and practice of textile finishing by bringing under one cover the widely scattered literature on the subject, including his own valuable contribution. The book running to XXI chapters covering 535 pages is indeed much more than an introduction—it is a veritable compendium or digest with a wealth of information embracing a variety of finishes, both traditional and modern, applicable principally to cotton, wool, silk and rayon, the chemical and physico-chemical methods being dealt with in greater detail than the purely mechanical finishes.

The general nature of the finishes applied to woven and knitted fabrics of various raw materials is covered by the Introductory chapter, while the finishing machines and mechanical finishes are completed in the Second, and crepe finishes in the Third. The next two chapters deal with the dispersion processes like mercerising, and the applications of Formal-dehyde. Three chapters thereafter are devoted to the various finishes for woollen goods like permanent setting, milling and non-felting, the latest developments being referred to. The next three chapters deal with the very useful anti-shrink processes for cotton, softening and starch finishes. The discounted practice of weighting, and delustering, chiefly applicable to rayon claim a chapter each. The chapter on cellulose derivatives explains the interesting process of coating fabrics with cellulose ethers and esters. The next two chapters deal with the remarkable modern finishes, the application both external and internal (thermo-plastic and thermo-setting) or synthetic resins, particularly urea-formaldehyde and their effect on fabric properties. The application of latex and synthetic rubber is covered by the next chapter. The last four chapters deal with the principal utility finishes, much perfected by the Quartermaster-General Corps, like water-proofing, moth-proofing, mildew-proofing and fire-proofing for which legislation is contemplated in the United States of America. The book ends with an excellent bibliography and a name and a subject index.

The exposition which is clear, concise and direct is mainly practical with a commendable restraint on mere theoretical intricacies. The author has drawn freely on the published patent and current technical literature, which makes the book at once authoritative and informative, references to English Journals being more frequent than to Amrican or German Journals. The author has done well in citing references to original literature in the text itself. The book is fully illustrated, particularly the earlier section, with a number of helpful photographs, line diagrams, tables of results and graphical representations.

The book is neatly printed and elegantly got up. Except for a few minor 'devils' like "ofl oose" for "of loose" (p. 345), "methylenure as" for "methylene ureas" (p. 397), "So° C" (p. 401), it is remarkably free from printing mistakes. The letter 'I' in the diagram on p. 245 is obscured.

While it is not clear why the author sometimes prefers the obsolete "artificial silk" to the modern "rayon", or "native" to "natural" cellulose or fibres, many would hesitate to accept his verdict that "textile English is not noted for its elegance" (p. 260). To a votary of science, the apology, "these tests and other methods of control, still form a valuable commercial asset *and cannot* be disclosed as yet" (p. 400), comes as a shocking anticlimax in a book written but to disclose.

Comprehensive as the volume undoubtedly is, a few items like use of tamarind size, test methods for evaluation of finishes on fabrics with test results and a few more nylon finishes would be welcome additions.

Aptly dedicated to the memory of John Mercer, the pioneer in textile finishing, this indeed is an up-to-date volume which every textile technologist should possess and could consult with great profit, useful alike to the teacher and the student, the mill supervisor and the research worker.

S. N. B.

Poisons. *Their Isolation and Identification.* By F. Bamford. Revised by C. P. Stewart. (J. & A. Churchill, London), 1947. Pp. 304. Price 21*sh.*

This book on Poisons was reviewed in 1940 when it made its debut as a first edition. There have not been many changes since then. It is to be regretted that though it has been written by an author who has worked in Egypt, it cannot be used extensively in India where the poisons and alkaloids used are not the ones which are emphasised in his book. That Poropyroxine colour reaction is not specific for Indian opium, has been drawn attention to, and it may be stated that given a sample of pure opium it would be impossible to dogmatise on its origin, i.e., whether it is Levantine, Turkish or Indian. It is rather unfortunate that the very fashionable Barbiturates have been discussed within two pages. A good index is appended. The book costs a Guinea—rather expensive from the Indian point of view.

C. V. NATARAJAN.

Elementary Analytical Chemistry. By Lyons and Appleyard. 14th Edition. (Churchill Ltd., London), 1947. Pp. 279. Price 9*sh.*

The volume under review is a classical textbook of qualitative and quantitative analysis that has served students of chemistry for generations in their preliminary university courses. In India the book is useful for Intermediate and Pass-course B.Sc. candidates. This edition, coming after the 1938 edition, has been thoroughly revised and brought up to date. A number of additional qualitative tests for the metals have been added, and the section on volumetric analysis has been extended by the inclusion of further exercises, including the use of potassium iodate and bromine as reagents. The usefulness of the volume could perhaps have been very much enhanced if a simple introduction to colorimetric methods of analysis had also been included. This section would be very welcome to students of general degree examinations, from whose ranks many a laboratory assistant and industrial analyst is drawn.

K. S. R.

SCIENCE NOTES AND NEWS

Scientific Research Association

Pandit Jawaharlal Nehru, the Prime Minister, was elected President of the Association of Scientific Research for the year 1948 at the annual meeting of the Association held at Patna.

According to the draft constitution of the Association, it will henceforward be run on Trade Union lines. The constitution also restricts the membership of the Association to Science Graduates and professionally competent scientific workers.

Science Congress Association

Sir K. S. Krishnan, Director of the National Physical Laboratory of the Government of India, and Dr. B. Mukherji, Director, Central Drugs Laboratory, Government of India, were elected President and General Secretary respectively of the Indian Science Congress Association for the year 1948-49 at the annual meeting of the Central Committee of the Association.

The following were elected members of the General Council of the Association: Dr. B. Mukherji, Dr. B. C. Guha, Dr. W. D. West, Dr. K. N. Bagchi, Dr. K. Venkataraman, Dr. A. C. Ukil, Dr. B. Sanjiva Rao, Dr. K. N. Bahl, Dr. U. P. Basu, Dr. Baini Prasad and Prof. G. P. Mazumdar.

The following were elected Presidents and Recorders respectively of the twelve Sections of the Association:—

Mathematics: Dr. S. Chowla and Dr. P. N. Das Gupta.
Statistics: Dr. V. S. Nair and Mr. S. Sen Gupta.
Physics: Dr. R. S. Krishnan and Dr. P. S. Gill.
Geology and Geography: Dr. C. Mahadevan and Dr. S. C. Chatterji.
Anthropology and Archæology: Dr. Nirmal Kumar Bose and Dr. M. N. Basu.
Medical and Veterinary: Dr. M. B. Soparkar and Dr. H. N. Ray.
Agricultural Sciences: Dr. R. S. Vasudeva and Mr. P. C. Raheja.
Physiology: Dr. B. B. Sarkar and Dr. N. P. Banawasi.
Engineering and Metallurgy: Prof. M. Sen Gupta and Prof. J. Ganguli.
Chemistry: Dr. P. B. Ganguli and Dr. D. Chakravarti.
Entomology and Zoology: Dr. M. L. Roonwal and Dr. H. D. Srivastava.
Botany: Mr. M. S. Randhawa and Dr. R. L. Nirula.
Psychology and Education: Mr. T. K. N. Menon and Mr. Kali Prosad.

Industrial Research Council

With effect from January 1, 1948, the Governing Body of the Council of Scientific and Industrial Research and the Board of Scientific and Industrial Research have been reconstituted as under for the period ending March 31, 1950:

1. *Governing Body of the Council of Scientific and Industrial Research*: Pandit Jawaharlal Nehru (*President*); Dr. Shyama Prasad Mookherjee (*Vice-President*); Mr. S. A. Venkataraman (*Ministry of Industry and Supply*); Mr. P. C. Bhattacharya (*Ministry of Finance*); Prof. M. N. Saha, Sir J. C. Ghosh, Sir S. S. Bhatnagar, Sir Sri Ram, Prof. S. N. Bose, Mr. G. L. Mehta, Mr. Kasturbhai Lalbhai, Sir A. L. Mudaliar, Dr. S. S. Joshi, Mr. Frank Anthony, Sir V. N. Chandavarkar, Mr. H. Sitarama Reddi, Dr. K. Hamid, Mr. G. D. Birla, Mr. N. V. Gadgil, Principal Niranuan Singh, Sir Ardeshir Dalal and Mr. J. R. D. Tata.

2. *Board of Scientific and Industrial Research*: Pandit Jawaharlal Nehru (*President*); Dr. Shyama Prasad Mookherjee (*Vice-President*); Mr. S. A. Venkataraman, Dr. B. C. Roy, Sir S. S. Bhatnagar, Sir K. S. Krishnan, Dr. Jivraj Mehta, Dr. K. L. Moudgill, Sir Abdul Halim Ghuznabi, Sir J. C. Ghosh, Prof. M. S. Thacker, Prof. Birbal Sahni, Mr. Kasturbhai Lalbhai, Prof. M. N. Saha, Sir Shri Ram, Dr. K. A. Hamid, Sir Ardeshir Dalal, Dr. H. J. Bhabha, the Scientific Adviser to G.H.Q., Sir C. V. Raman, Mr. D. N. Wadia and Dr. J. N. Mukherjee.

Commonwealth Collection of Type Cultures

The Hon'ble Vice-President, Council of Scientific and Industrial Research and Scientific Consultative Committee, Governmnt of India, has nominated Mr. M. Sreenivasaya, Lecturer in Fermentation Technology, Indian Institute of Science, Bangalore, as a member of the Permanent Committee of the Commonwealth Col-,lection of Type Cultures in London.

Bose Institute

The Bose Institute, Calcutta, celebrated the 30th Anniversary of the Foundation of the Institute on the 30th November 1947 under the presidency of H. E. Sri. C. Rajagopalachari, Governor, West Bengal. Dr. J. N. Mukherjee, Director, Indian Research Institute, Delhi, delivered the Jagadish Chandra Memorial Lecture on "Some Scientific and Practical Problems of Agriculture in India".

Central Institute of Education

On Friday, the 19th December 1947, the Central Institute of Education was opened in Delhi by H. E. the Countess Mountbatten of Burma. A grant of Rs. 18 lakhs and about Rs. 2·5 lakhs for equipment have been sanctioned towards this project. This has been instituted in accordance with the plan of the Government of India to provide "Model Teachers" for the various provinces and states in the country.

The Indian Dairy Science Association

The "Indian Dairy Science Association" has been founded at Bangalore. A meeting of the Executive Committee was held at New Delhi on the 16th December with Sir Datar Singh in the Chair. It was decided to open the membership of the Association to all persons engaged in teaching, research and advisory work in dairying, or holding technical positions in the field of dairying. The Association's aim is to

publish a Journal devoted to Dairy Science and fill up a long-felt want in this direction.

The headquarters of the Association is located at the Indian Dairy Research Institute, Bangalore. Members who wish to join the Association may communicate with the Joint-Secretary of the Association.

Soil Research Station in Madras

Mr. N. V. Gadgil, Minister for Works, Mines and Power, Government of India, opened in Madras the Concrete Laboratory and the Soil Engineering Research Station built in connection with the Ramapadasagar Dam on 19th December 1947.

Conference on Compost

On the initiative of Shrimati Mira Behn a Conference of workers and others interested in the Compost Programme was held in the Secretariat Buildings, New Delhi, on the 16th and 17th of December 1947. The Conference was opened by the Hon. Dr. Rajendra Prasad.

The Conference resolved that a systematic utilisation of urban and village wastes would yield about 110 million tons extra manure, while a programme for providing alternative fuel in place of cow dung would release another 200 million tons of manure, which would increase our food production by about 12-15 million tons and at the same time provide additional fodder.

Resolutions were also passed suggesting methods of implementation of schemes for country-wide production and utilisation of compost.

Research Scholarship

One Science Research Scholarship will be awarded this year by the London Exhibition of 1851 to students from Indian Universities or institutions having post-graduate departments of Science. The scholarship, which is of the value of £350 per annum and tenable for a period of two years, is intended to enable the selected student, who has already completed a full University course and whose record gives evidence of capacity for original scientific investigation, to devote himself to post-graduate research in some branch of pure or applied science at any institution abroad approved by the Commissioners.

Subjects of the Dominion of India and Indian States, below the age of 26 years on May 1, 1948, will be eligible for this scholarship. Applications from students, whether residing in India or abroad, have to be recommended by the authorities of a University or an institution and are to be made to Provincial Governments and Local Administrations through the Universities and institutions concerned, who would forward them so as to reach the Secretary, Ministry of Education, Government of India, not later than 10th March 1948.

Scholarship in Minerology

Dr. Ben H. Parker, President of the Colarado School of Mines, U.S.A., has announced that a scholarship at the School of Mines will be awarded annually, beginning with the school year 1948-49, to a resident of India upon the recommendation of the Minister of Education.

The scholarship meets all tuition expenses (now $425 a year), and is renewable for a maximum of 4 years provided the student maintains satisfactory record. Deposits, special student fees, summer session tuition and living and other personal expenses are not included.

The Colorado School of Mines trains students in mining, metallurgy, geology, petroleum production and petroleum refining with options in fuel engineering and geophysics, and elective courses in the production and utilisation of cements, refractories, clays, and other non-metallic minerals.

The Minister of Education's recommendation must reach the office of the President of the School by June 15, 1948. Further particulars may be obtained from the United States Foreign Embassy.

Lady Tata Memorial Trust

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1948-49 commencing from 1st July 1948. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only, and the holders must undertake to work whole-time under the direction of the head of a recognised Research Institute or Laboratory. The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications should reach by March 15, 1948. Further particulars may be had from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay 1.

Lord Rayleigh OBITUARY

Lord Rayleigh, the distinguished physicist, passed away on December 13.

Born in 1875, he studied at Eton and Cambridge, from where he passed out with First Class Tripos in Natural Science. After working for a number of years at the Cavendish Laboratory, he became Professor of Physics at the Imperial College of Science.

Lord Rayleigh was interested in a wide range of subjects, including agriculture and dairy farming. He was more of a skilled experimentalist than a theoretician, and studied common phenomena like the evening sunlight and the shapes of stones. He was elected an F.R.S. and also to the Presidentship of the British Association, two honours which incidentally, his father had also received.

Srish Kumar Sen

We regret to record the death of Srish Kumar Sen, a noted systematic Botanist and a retired Government servant of Bengal, on October 9, 1947. An active member of the Dacca Botanical Society and an organiser of the University Botanical Gardens and Herbarium at Dacca, Sen was responsible for bringing into light many new species of plants of Bengal. Sen was also a great patriot who had been charged in the famous Arabindo case of 1908. His loss is deeply regretted by all his friends and admirers, who are many.

62-48 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for The Current Science Association, Bangalore

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

The Council of Scientific & Industrial Research invite applications for the post of Director, Road Research Institute, to be established in India. Candidates must possess a high degree in Engineering and also in Physics and Chemistry, have had extensive experience in a responsible capacity in a well-known Road Research Institute and have made some notable contribution to research work. A working knowledge of French, German, Italian or any one or two of them is desirable.

No age-limit is prescribed provided the applicant is physically fit for 5 years arduous work in India. Minimum salary will be Rs. 2,000 per mensem in the scale Rs. 2,000-100-2,500, but the Council may consider the grant of a higher salary to an exceptionally qualified candidate. The appointment is non-pensionable and will be for 5 years on a contractual basis. The candidate selected will be eligible to the benefits of the Council's Contributory Provident Fund, the rate of his subscription being 6¼% with the Council contributing an equal amount.

Leave, passage, etc. will be governed by rules laid down by the Council.

The selected candidate will initially be required to study Indian conditions for 3 to 6 months and thereafter to draw detailed plans for setting up Road Research laboratories in India. He will also be required to coordinate all branches of road research in this country and to disseminate information on all aspects of such research.

Canvassing in any form will be considered a disqualification. Two copies of the application, together with copies of testimonials and published papers, should be sent so as to reach the Secretary, Council of Scientific & Industrial Research, P-Block, Raisina Road, New Delhi (India), not later than the Ist March, 1948.

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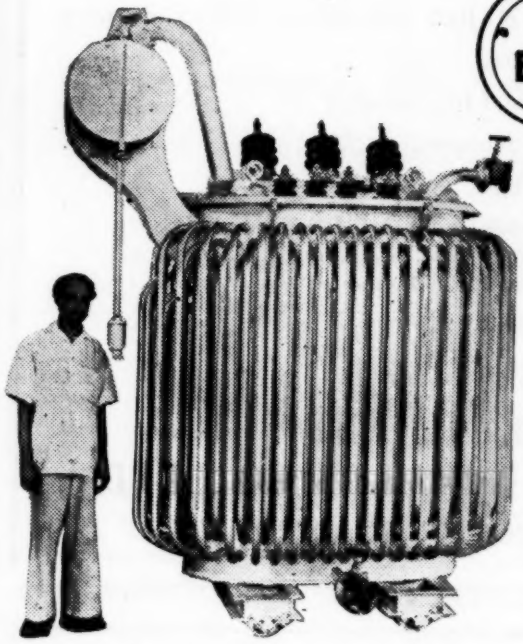

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The Demonstrators should at least be M.Sc.'s and have sufficient research experience. They will be expected to help in the research work of students.

Selected candidates will be entitled to the benefit of Provident Fund. Canvassing directly or indirectly will disqualify.

Six copies of applications together with testimonials, statement of qualifications and published work in the case of post No. I and one copy in the case of post Nos. 2 to 5, should reach Captain M. Bashir, B.Sc. Hons. (Edin.), Registrar, University of the Punjab, Lahore, by the 14th February 1948.

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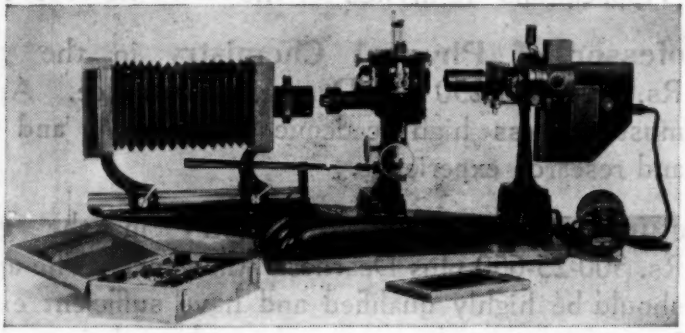

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